GEOGRAPHY, RESOURCES & INDUSTRIES

EDISON ELECTRIC INSTITUTE BULLETIN

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February, 1943

Charting the Course in Accident Prevention . . . . . W. T. ROGERS 33

Socio-Economic Conditions and Intercity Variations of Electric Use . . . . . HENRY G. KNAF 36

What a Group of Connecticut Business Men Are Doing About Taxes . . . . . C. L. CAMPBELL 45

Sell Today—Deliver Tomorrow . . . . . C. E. GREENWOOD 47

Value of Good Lighting in War Production—An Important Survey 49

Twenty-four Edison Electric Institute Awards for Resuscitation Made in 1942 . . . . . MAE B. WOODS 52

Allocating Gross Revenues to Production, Transmission and Distribution Facilities . . . . . NORMAN F. BROWN 57

Reports of Joint Subcommittee 62

Personals 63

Conventions and Meetings, 64

THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

November, 1942

SOURCE AND DISPOSAL OF ENERGY—MONTH OF NOVEMBER

	1942	1941	%
GENERATION (Net)**			
By Fuel Burning Plants	10,723,215,000	10,400,000,000	+ 3.1
By Water Power Plants	5,730,380,000	4,086,100,000	+40.2
Total Generation	**16,453,595,000**	**14,486,100,000**	**+13.6**
Add—Net Imports Over International Boundaries		80,814,000	.....
Less—Company Use	(Details	268,542,000	.....
Less—Energy Used by Producer	not	309,438,000	.....
Net Energy for Distribution	available)	**13,988,934,000**	.....
Losses and Unaccounted for		1,680,968,000	.....
Sales to Ultimate Customers	**14,096,849,000**	**12,307,966,000**	**+14.5**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of November 30th			
Residential or Domestic	26,622,919	25,955,582	+ 2.6
Rural (Distinct Rural Rates)	1,100,069	984,328	.....
Commercial or Industrial:			
Small Light and Power	4,232,813	4,295,223	− 1.9
Large Light and Power	150,856	174,183	
Other Customers	124,847	121,541	.....
Total Ultimate Customers	**32,231,504**	**31,530,857**	**+ 2.2**
KILOWATTHOUR SALES—During Month of November			
Residential or Domestic	2,343,456,000	2,266,037,000	+ 3.4
Rural (Distinct Rural Rates)	197,372,000	169,892,000	+16.2
Commercial or Industrial:			
Small Light and Power	2,307,722,000	2,163,485,000	+ 1.9*
Large Light and Power	7,948,208,000	6,671,829,000	+21.0*
Street and Highway Lighting	196,814,000	205,874,000	− 4.4
Other Public Authorities	390,829,000	281,375,000	+38.9
Railways and Railroads:			
Street and Interurban Railways	363,004,000	327,422,000	+10.9
Electrified Steam Railroads	205,201,000	175,237,000	+17.1
Interdepartmental	144,243,000	46,815,000	+208.1
Total to Ultimate Customers	**14,096,849,000**	**12,307,966,000**	**+14.5**
Revenue from Ultimate Customers	**$246,749,300**	**$234,152,800**	**+ 5.4**

* Based on changes made in same classification both years

RESIDENTIAL OR DOMESTIC SERVICE (Revised Series)

AVERAGE CUSTOMER DATA—For the 12 Months Ended November 30th			
Kilowatthours per Customer	1,019	983	+ 3.7
Average Annual Bill	$37.50	$36.76	+ 2.0
Revenue per Kilowatthour	3.68¢	3.74¢	− 1.6

** By courtesy of the Federal Power Commission

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DISON ELECTRIC INSTITUTE BULLETIN

lume 11 FEBRUARY, 1943 No. 2

Charting the Course in Accident Prevention

By W. T. Rogers

Consultant, Insurance and Safety Department, Ebasco Services Incorporated

SOONER or later you have to get back to 'em—statistics. Almost everyone when he begins to take active interest in accident prevention rk says to himself something like this. o h—— with all these d—— statis-. I'm not going to waste my time llecting and analyzing figures. I'm g to spend my time constructively in actual work of putting a stop to acci-nts." Fine sentiments, but it isn't long, ending upon the one-track-minded-s of the individual making the remark, ore he resorts to statistics realizing at to do an honest-to-goodness accident evention job he must at least know the owing:

1. How frequent are accidents occur-g in the organization and how severe e they?
2. What has been the past accident perience of the organization?
3. How does the accident experience the organization compare with other anizations doing similar work?
4. What is the experience of the in-stry of which the organization is a rt and how does its experience com-e with the experience of other indus-s?
5. What are the possibilities for im-vement?

To do an accident prevention job in individual organization will involve ourse, a great deal more detailed in-nation based upon accurate accident orts. Such information should in-de data with respect to where, when, d how, and why the accidents occur-, and other details necessary for de-ination of the course and scope of accident prevention program. Such dies as that made by the accident pre-ion committee as reported by Mr. C. Beardsley in the January 1937 EEI LLETIN, showing cause and location 4 fatalities and 2,929 lost time acci-s are especially important.

Accurate records of the cost of accidents should also be kept, including direct charges such as insurance, compensation, medical, legal, and claim department expense together with so called indirect costs including spoilage or damage of material and equipment, lost time of supervisors and fellow workmen, training of replacements, etc. These costs worked out as ratios such as accident cost per employee, or per $100 of revenue or per customer will also be useful.

While most accident prevention programs are motivated by humanitarian purposes and a genuine desire to improve working conditions, cost figures such as mentioned above will often present in themselves a powerful argument for carrying forward a first class accident prevention program. It can very easily be demonstrated that for every dollar spent wisely in accident prevention work several dollars are saved the organization in accident cost.

The purpose of this article is to discuss the broader aspects of the problem industry-wise so—as the old campaigner used to say—"let's look at the record"—the statistics.

Some 2,000 fatal accidents have not occurred in the electric light and power industry that otherwise would have happened if fatalities had not been reduced from 1.8 per 1,000 employees per year in 1925 to 0.5 per 1,000 in 1941. In 1924 there were 10 lost time accidents per 100 employees per year compared with 2.3 per 100 in 1941—and in 1926 there were 165 days lost per 100 employees per year as compared with 61 per 100 in 1940. This record as graphically portrayed in the charts on page 34 indicates a remarkable achievement, and while many groups such as the National Safety Council, the various engineering societies, and individuals in the companies making up the industry can share in this pride of accomplishment, the Accident Prevention Committee of the Institute has had a large part in this accomplishment. The NELA Committee under the chairmanship of Mr. K. R. MacKinnon had an extremely difficult row to hoe when they set out upon a campaign to substantially reduce the accident rate of the industry from the peaks as disclosed by the original statistics which that committee assembled for the first time. Safety was "sissy stuff" in those days and the idea of accident prevention had nowhere near the public acceptance which it has today. That committee and subsequent early committees had one advantage which, operating like the law of diminishing returns, the present and future committees will lack. The field was "wide open" and almost any action taken could not help but produce measurable results. Emotional appeals alone could be depended upon for substantial reductions in accident rates. Such appeals while still an important part of any safety program must be augmented by many other methods of attack. More "scratching" is required today as constantly better records are being achieved.

Persons familiar with the mechanics of statistics will realize that charts such as those shown are merely indicative and that there are many factors "behind" such curves which should be borne in mind when interpreting them.

For example, the length in the workweek has declined during the period shown on the charts with consequent reduction in exposure per employee. Mr. D. C. Stewart in a paper (Appendix 18-B to Minutes of Eighteenth Meeting of Accident Prevention Committee EEI) points out that all industry shared a general decline in accidents during the period 1926 to 1934. He also calls attention to the decline in the volume of construction work done by utility employees which it seems reasonable to suppose would have a decided effect on the

decline in accidents in the industry since the frequency rate for construction is almost three times as great as the rate for public utilities.

On the other hand, as a compensation for the effect of these factors, it is a well known fact that more accidents are reported today than was formerly the case. It should also be borne in mind when viewing these charts that the accidents recorded are only those which happened to cause lost time and that for each one of these there may have been hundreds, any one of which except for fortuitous circumstances might have been more serious with consequent dire effect on the good record shown.

Mr. Beardsley, another former Chairman of the Accident Prevention Committee, suggested that instead of making comparisons between companies which may be operating under different conditions, each company should gage its score against Par, and that Par should be "no accidents." The achievement of Par by each company would be one surefire way of improving the industry record, but there is no doubt a great improvement in the industry picture could be achieved by the poor-accident record companies becoming as good as the good-accident record companies now are—and some of the latter, particularly some of the larger companies are very good indeed. Philadelphia Electric, for example, last year received an honorable mention certificate from the National Safety Council for having gone 1,341,360 man hours without a reportable injury.

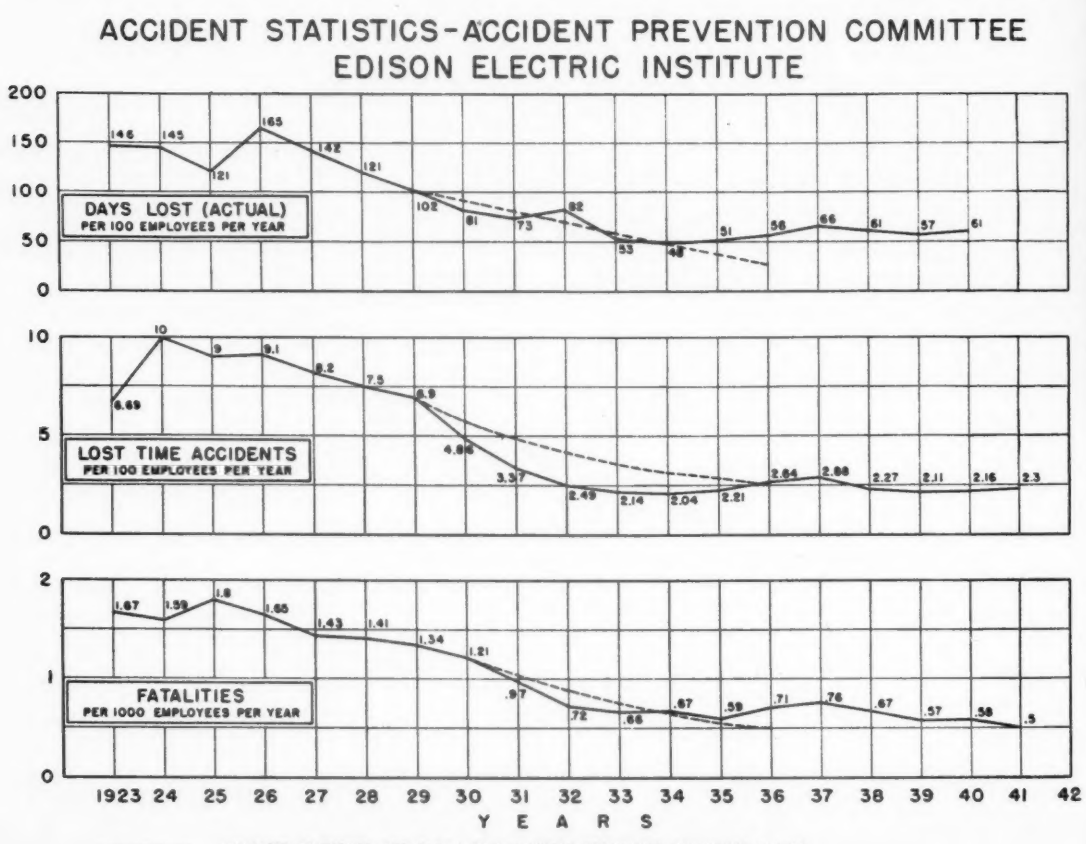
Mr. W. R. Smith, Chairman of the 1939-1941 Committees in an article in the EEI BULLETIN of July 1941, quoted figures of 23 companies having 56,805 employees, which over a three months' period had no fatalities, had 1.61 lost time accidents per 100 employees per year, and 29.61 days lost per 100 employees per year. Compare these figures representing 5% of the reporting companies having 20% of the employees with the charts shown below and an idea may be gained of the possibilities inherent in the situation if only the things we now know how to do could be universally applied.

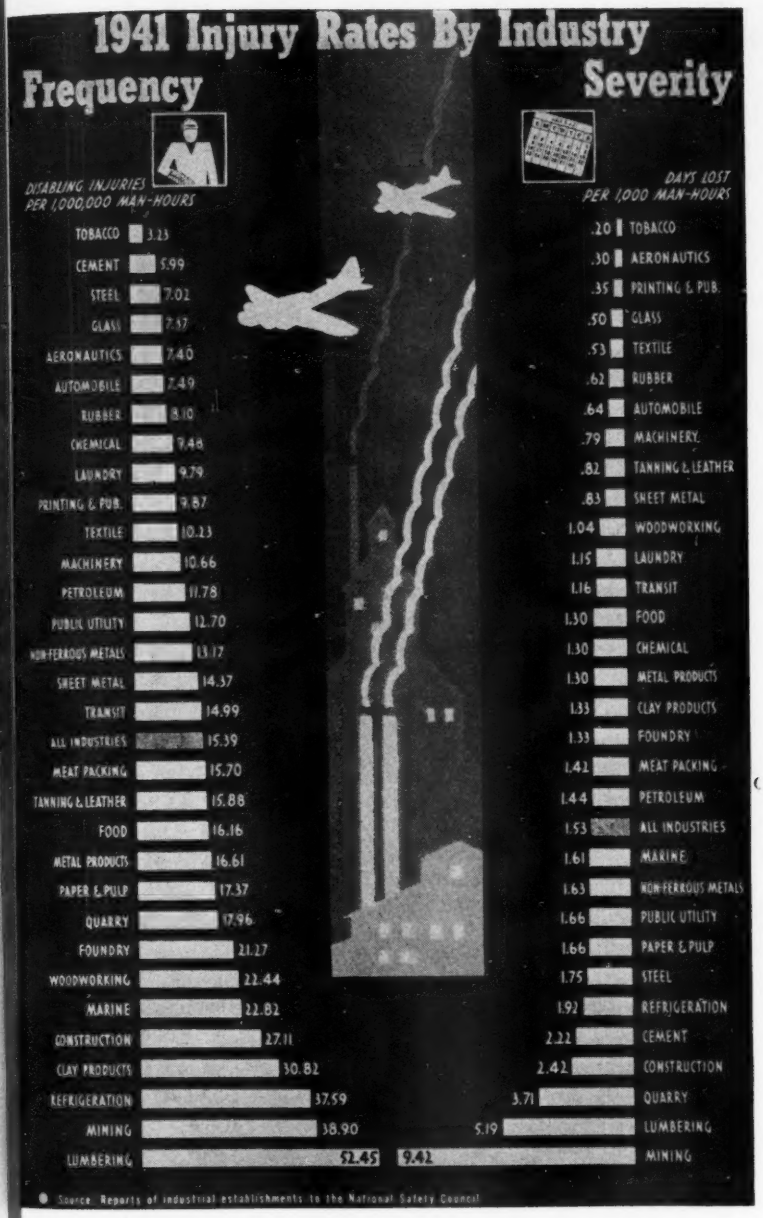
In 1940 the Accident Prevention Committee decided to adopt the system of accident reporting prescribed by the American Standards Association so that the accident data would be on the same basis as that of other industries reporting to the National Safety Council. change was made because of the d of the committee to have the indu statistics on a comparable basis with industries and to eliminate certain d cations in reporting on the part of companies who reported to the Ins and also to the National Safety Cou In accordance with new arrangem the Institute will now furnish ele light and power accident statistics t Council. Using this new method, quency and severity rates are obta as follows:

Frequency rate—the number of inj per one million man hours of posure.

Severity rate—total time charges one thousand man hours of expo

In computing the frequency rate, number of injuries includes the num of deaths, permanent total disabil permanent partial disabilities and porary total disabilities. In compu the severity rates, certain arbitrary charges are set up for various degre injury. For example, death—6 days, permanent total disability—6 days, loss of arm above elbow—4 days, hand—3,000 days and so


ACCIDENT STATISTICS-ACCIDENT PREVENTION COMMITTEE
EDISON ELECTRIC INSTITUTE
DAYS LOST (ACTUAL)
PER 100 EMPLOYEES PER YEAR
LOST TIME ACCIDENTS
PER 100 EMPLOYEES PER YEAR
FATALITIES
PER 1000 EMPLOYEES PER YEAR
1923 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Y E A R S
INDICATES OBJECTIVES SET UP BY N.E.L.A. ACCIDENT PREVENTION COMMITTEE IN 1929
GIVES ACTUAL RESULTS REPORTED ON A COVERAGE OF APPROXIMATELY 90% OF INDUSTRY'S EMPLOYEES
12-1-41



tual days lost are counted for tem-rary total disabilities. For further de-ls see ASA Standard Z16.1-1937.

Reports from companies covering 8,765 electric department employees h an exposure of 541,979,000 man rs were received by the Institute cov-ng the year 1941, and are tabulated EEI publication J9, December 1942, tled "1941 Accident Statistics of the ctric Light and Power Industry." e summary shows:

rage No. of Employees—268,765
. of Hours Worked—541,979,000
mber of Disabling Injuries
Death—134.5
Permanent Total Disability—6
Permanent Partial Disability—181
Temporary Total Disability—6,155
Total—6,476.5

Days to be Charged as Result of Disabling Injuries
Death—807,000
Permanent Total Disability—36,000
Permanent Partial Disability—94,285
Temporary Total Disability—134,094
Total—1,071,379

Injury Rates
Frequency—11.95
Severity—1.98

The adjoining chart from 1942 Accident Facts (NSC), shows how the entire public utility industry compares with all other industries reporting to the National Safety Council in 1941.

The frequency column of this chart shows frequency for the public utility industry as a whole at 12.70, whereas for the same period the electric light and power inrustry frequency was 11.95—slightly better. The severity rate for electric light and power companies at 1.98, however, was decidedly higher than the all public utility rate of 1.66.

While the record of achievement of the electric light and power industry has been excellent, a great deal still remains to be done. As a matter of fact, Mr. Stewart in his paper previously referred to suggests that we should cease dwelling on the glories of the 1926 to 1934 period in which a remarkable decline took place and recognize the fact that during the past seven years "the industry has been on dead center as far as reducing accident rates goes." Much therefore remains to be done, and while it is doubtful that accidents can ever be entirely eliminated the industry should not be satisfied until it stands at the head of all American industries. It has substantial advantages over most industry in having on the whole, steady, reliable employees with strong company ties, and supervisors with a record of long years of experience and technical excellence. Economic factors making for comparative stability of operations also insure continuous accident prevention activities.

The writer takes this opportunity to suggest some of the more important methods of approach—but to paraphrase current radio jargon, "these suggestions do not necessarily carry the endorsement of the Accident Prevention Committee. While a book could very easily be written on the subject of these suggestions (not original by any means) only the barest outline of the main points can be considered here. They are:

1. Recognition on the part of top management of its responsibility for safety. Mr. W. E. Mitchell, Vice President and General Manager of Georgia Power Company in an address before the 29th National Safety Council stressed the responsibility of management for safety and told how his company meets this responsibility. He emphatically stated that responsibility for safety cannot be delegated. Mr. Mitchell's talk was printed in the BULLETIN in October 1940.

2. Improvement of employment techniques. Selection of the right man for

(*Continued on page 44*)

Socio-Economic Conditions and Intercity Variations of Electric Use

By Henry G. Knaf

Division Engineer, Bureau of Economic Research, Consolidated Edison Company of New York Inc.

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THE purpose of this study is to show by statistical means that the differences in social and economic conditions must be given considerable weight in judging the differences in domestic electric use among the larger cities of the United States. The statistical measures used are correlations, separately correlating each of the many factors representing living conditions with a measure of electric use. The fact that these factors can be singled out and successfully correlated with electric use in the presence of different rates in these cities is attesting to the magnitude of their effect.

The influence of such socio-economic factors upon domestic electric use has long been recognized and a number of excellent studies here and abroad are available on this subject. For instance, relationships between number of rooms, persons per family, or income on one side and electric use or appliance ownership on the other, have been shown conclusively to exist so that they may be accepted as economic laws. Each of these studies, even though dealing with large samples of consumers, confines itself to one city, usually showing the variables (number of rooms, persons per family, income, rent, etc.) by small steps and over a wide range. It goes without saying that with the investigation being confined to an area where the same rates prevail the rate factor as a possible determinant of electric use is excluded.

To explore the relationships between these factors and domestic use in a number of cities is quite a different problem. Here it is no longer possible to show the variables by small steps and over a wide range, but since each city is represented by only one figure for each variable, the lowest and highest city will determine the range. For instance, while the median monthly electric consumption per consumer runs from 20 to 70 kilowatt hours, the number of persons per family ranges only from 3.2 to 4.2 in the different cities, and the close bundling of points precludes any reasonable correlation. This of course does not mean that there is no relationship between persons per family and electric use. There undoubtedly is; but variations between cities in this respect are not great enough to demonstrate it successfully and precisely.

However, the problem here is not so much to establish relationships between socio-economic factors and electric use — this can be done more effectively in uniform rate areas — but to determine whether such relationships are strong enough to give satisfactory correlations when tested for a number of cities. In so doing one has to bear in mind that only one factor at a time is correlated with electric use and that all the other socio-economic factors as well as rate differences and variations in promotional efforts of companies are acting on electric use at the same time.

Existing Studies Involving Socio-Economic Factors and Electric Use

There are two outstanding studies[1] in which the statistical means of correlation has been used in connection with domestic electric use.

The first study deals with a number of communities in the territory of the Public Service Company of Northern Illinois and, to the knowledge of the author, is the first systematic attempt to demonstrate the relationships between purchasing power, or rather indicators of purchasing power, and electric use for a number of communities. The two authors point out that "the complicated array of factors present in any situation to be analyzed prevent the use of simple and direct means of measuring the effect of each." They decided, in view of the difficulties involved, to confine their study to communities which were located in a uniform rate area. In this re the present study goes beyond t inasmuch as it deals with cities ing widely different rates. Neverth their study is an important contrib to a comparative analysis of the var of electric use levels in different munities.

The study by Warren M. Pe concentrates on electric refrigerator sities in the different states as influe by climate and by rates. He finds correlation exists between climate refrigerator saturation but that th none between rates and refrigerato other words, climate does, but rat not influence refrigerator density i different states. In addition, Prof. sons demonstrates that refrigerator sity is also affected by income leve expressed by the ratio of income ta turns to domestic electric consume

Scope of Study

This study concentrates entirel social and economic factors, relate the cities and their personnel, w directly or indirectly act upon ele consumption. Thus only such fa are considered here which lie outsid control of the utilities. The el range and water heater situation i yond the scope of this study inas as the attitude of the companies re ing these appliances is a vital ele in their development, with ho social and income factors playin insignificant part, as will be disc later. No attempt is made to discus differences and their possible caus

The field for the study is the 9

[1] W. J. Crowley & C. H. Baily, "The Relation of Electricity Consumption to Purchasing Power," *The Journal of Land & Public Utility Economics*, November, 1937, pp. 350-59; and Warren M. Persons, *Influence of Climate and Rates on Electric Refrigerator Sales*. Edison Electric Institute Bulletin, New York, November, 1936.

[2] Cf., W. F. Ogburn, "Social Characteri Cities," International City Managers Asso September, 1937, Chicago: E. L. Thorndik Woodward, "Individual Differences in Ar Cities: Their Nature & Causation," *Americ nal of Sociology*, September, 1937: E. L. Th "Variations Among Cities in Per Capita In *Journal of American Statistical Association*, S ber, 1937: E. L. Thorndike, *Your City*, New Harcourt, Brace & Co., 1940: E. L. Th "The Influence of Disparity of Incomes on fare," *American Journal of Sociology*, July, E. L. Thorndike, "Variation and Correlat Institutions, Activities, and the Personal Q of the Residents," *Annals New York Acad Sciences*, December, 1939.

the United States having a population 100,000 and over, according to 1937 imates, and the 92 companies serv- them.

Socio-Economic Data for Cities

The selection of the statistical mate- for the cities was greatly facilitated a number of comparative sociological udies of American cities[2] which indi- te the extent and availability of eco- mic and social measures necessary for study of this kind.

The factors which are to be correlated h electric use can be divided into ee groups; namely, housing condi- ns, social characteristics and income. e first group includes the number of ms per dwelling unit, per cent home ners, per cent apartment dwellers, owding" as expressed by persons per m, duration of occupancy and rent. e second group (social characteris-) contains the following measures: cent foreigners, workers per family, cent women working, infant mor- ity and high school attendance. The t group (incomes) consists of indus- al wages, income taxpayers, new car s and telephones, the latter two being arded as indicators of income. In dition, electric use and gas use are rrelated and also temperatures and rigerator saturation. Besides these asures quite a number of others have en investigated for their possible effect consumption. Some of these are dis- ssed subsequently as being instructive spite of their lack of correlation.

Data on Electric Use for Companies Serving the Cities

After the data for the 94 cities was embled, the names of utility com- nies, gas as well as electric, serving in se cities and the population in their ply areas were obtained. In most s the company supply areas extend ond the cities' political boundaries, with the electric companies usually serving larger areas than gas companies. There are some instances where several cities with more than 100,000 population are located in the area of one company; sometimes two companies—often a municipal and a private company—are serving in one city. In those instances the data for the cities or the companies were weighted and combined. Cases where the city population constitutes only a small part of the total population served by the company were eliminated because the city for which the socio-economic factors are given would not be representative of the company for which the data on electric use are shown.

Further, if electric use is to be correlated with socio-economic factors in the cities, the saturation of electrified homes becomes of great importance. It stands to reason that one city which has only 70 per cent of its homes electrified may — other things being equal — show a higher electric use per consumer than another city which is 100 per cent electrified and includes families in the lowest economic levels. Therefore, saturation figures on electric homes were developed for the different cities using 1930 Census figures, 1934 Real Property Inventory data, and finally, the companies' reports to the Federal Power Commission which in one of their schedules asks for the number of consumers detailed for cities above 2,500. These figures were then used to adjust electric use and refrigerator saturations.

The average kilowatt hour use per consumer — the most commonly used measure of domestic electric use — was obtained for all the companies, also the average gas use, exclusive of house heating, adjusted for heat content. Besides, data on saturation of electric refrigerators, as far as reported, were collected.

After some preliminary experiments with the average per consumer electric use, the insufficiency of this measure (to be demonstrated subsequently) for the purpose of correlation with the various socio-economic factors and the need for a more refined instrument became apparent. This was found in the frequency distribution of domestic consumers by kilowatt-hour steps, sometimes called block analysis, which is reported to the Federal Power Commission by the electric utilities.

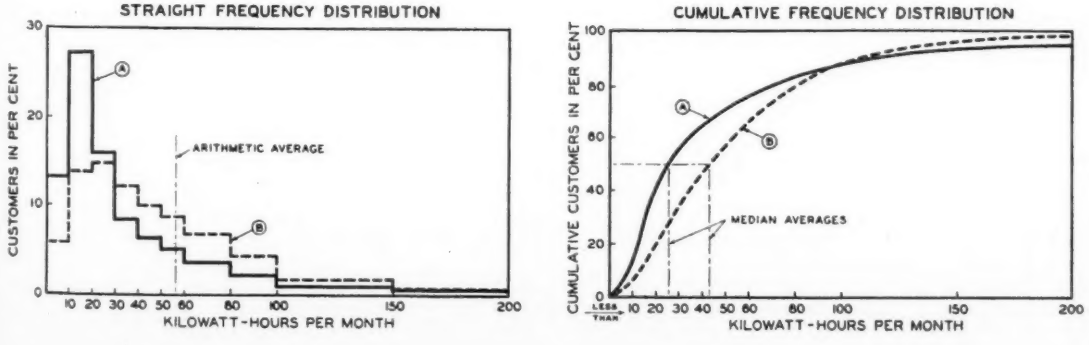
Frequency Distribution of Consumers by Kwhr Blocks

In the frequency distribution or block analysis the consumers are grouped by blocks or steps of kilowatt hours. The Federal Power Commission schedule calls for steps of 10 kwhr up to 60, then of 20 kwhr up to 100, then of 50 kwhr up to 200, and of 100 kwhr above 200. The actual number of consumers in each block can be expressed in per cent of the total number of consumers to facilitate comparisons between the frequency distributions of different companies. For many purposes the cumulative form, a progressive addition of the percentages of consumers in the different kilowatt-hour blocks, is more convenient. For instance, one can immediately determine from it the so-called median which is that amount of kilowatt-hours which divides the consumers into two equal parts, with one-half of them using less than the median and the other half using more.

Insufficiency of the Average Kwhr Use per Consumer

The frequency distribution provides a means to demonstrate the insufficiency of the commonly used arithmetic average for the exploration of relationships between social and economic factors and electric use. (Fig. 1). Two companies, called A and B, are shown which have practically the same average monthly use

FIG. 1 TWO FREQUENCY DISTRIBUTIONS FOR THE SAME AVERAGE ELECTRIC USE



HOUSING CONDITIONS AND ELECTRIC USE

FIG. 2 ROOMS PER DWELLING UNIT AND RESIDENTIAL ELECTRIC USE

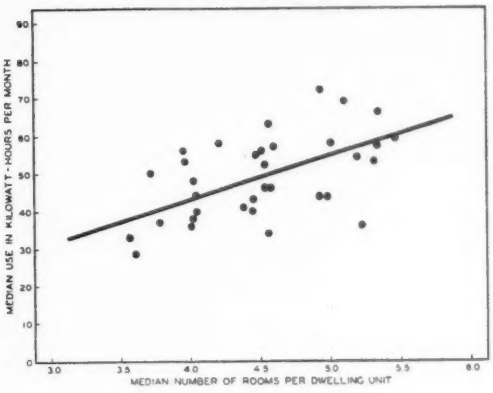


FIG. 3 CROWDING OF DWELLING UNITS AND LOW-USE RESIDENTIAL CUSTOMERS

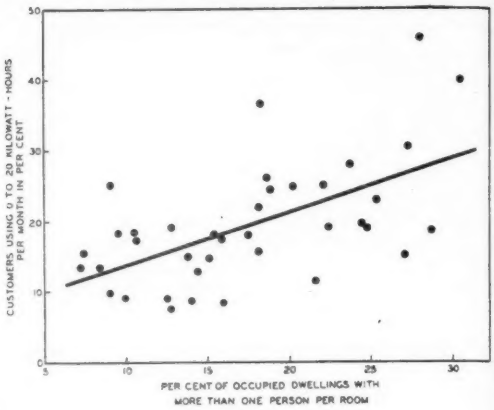

CUSTOMERS USING 0 TO 20 KILOWATT-HOURS PER MONTH IN PER CENT
PER CENT OF OCCUPIED DWELLINGS WITH MORE THAN ONE PERSON PER ROOM

FIG. 4 HOME OWNERSHIP AND RESIDENTIAL ELECTRIC USE

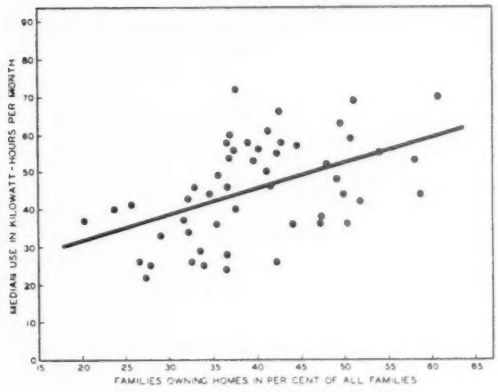


FIG. 5 FAMILIES IN APARTMENTS AND RESIDENTIAL ELECTRIC USE

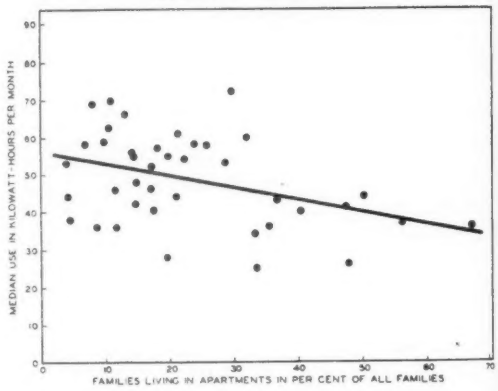


FIG. 6 DURATION OF OCCUPANCY AND LOW-USE RESIDENTIAL CUSTOMERS

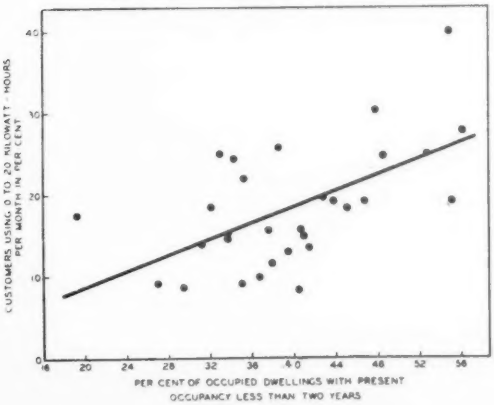
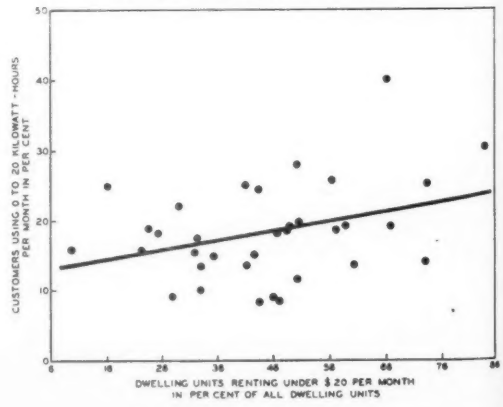

CUSTOMERS USING 0 TO 20 KILOWATT-HOURS PER MONTH IN PER CENT
PER CENT OF OCCUPIED DWELLINGS WITH PRESENT OCCUPANCY LESS THAN TWO YEARS

FIG. 7 RENTALS UNDER $20 PER MONTH AND LOW-USE RESIDENTIAL CUSTOMERS


CUSTOMERS USING 0 TO 20 KILOWATT-HOURS PER MONTH IN PER CENT
DWELLING UNITS RENTING UNDER $20 PER MONTH IN PER CENT OF ALL DWELLING UNITS

er consumer; namely 57 and 56 kwhr. A glance at the frequency curves — shown in straight and cumulative form — reveals that the distributions of consumers in the two companies differ considerably. Company A has a large number of low use consumers, 40 per cent using less than 20 kwhr, while Company B shows only 20 per cent with less than 20 kwhr. On the other hand, Company B has only 1.6 per cent of the consumers using more than 200 kwhr while A has more than 5 per cent of such consumers. Or to describe the two companies in terms of the arithmetic average use, Company A has 75 per cent of the consumers using less that this average while Company B has only 60 per cent. The median for Company A is 25 kwhr while for Company B it is 43 kwhr. Obviously, the social and economic conditions of the consumers which underlie these frequency distributions show differences which the monthly average use entirely fails to express.

But the most serious shortcoming of the arithmetic average is the overemphasis it places on the heavy duty appliances. A 20 per cent range and a 10 per cent water heater saturation, for instance, would add nearly 500 kwhr to the average use per consumer per year. But whatever may be the merits of these heavy duty appliances with respect to the operations of the utilities or in the eyes of the consumers; from the social point of view, electric cooking and water heating does not constitute a significant element in the standard of living as long as one can cook just as well and cheaply by gas—as is the case in the larger part of American communities—or as long as water can be heated just as conveniently and cheaply by other types of fuel. Conversely it is not so much the standard of living, i.e., economic and housing conditions,[3] which determine the extent to which electric heavy duty appliances are used in the different communities of the United States as the competitive price and availability of alternative fuel.

Median Kilowatt-Hour Use

Now, the median kilowatt-hour use which can be obtained from the frequency distribution eliminates or at least reduces the influence of consumers in the higher use brackets and thus more nearly expresses the use of a majority of the consumers. For none of the companies included in this investigation does the saturation of electric ranges or water heaters approach 50 per cent so that the median in all cases does not include any heavy duty appliance users. Besides, experience shows that in most cases the majority of electric ranges and water heaters are found beyond the gas mains and that means quite often outside the city limits. But since socio-economic data are given for the cities and electric use is given for the companies—usually supplying territories larger than the cities—there is an added reason to have a measure which minimizes the effect of heavy duty appliances.

However, not all the factors introduced in this study are correlated with the median use. There are some measures such as crowding, infant mortality and others which are indicators of a low standard of living, the effect of which should express itself more strongly in the lower part of the frequency distribution. Therefore, such measures are correlated with the percentages of consumers using less than 20 kwhr, an amount which means scarcely more than a limited use of lighting, a radio and a flat iron and which, so to speak, represents an electric "subsistence level."

Various Socio-Economic Factors and Their Correlation with Expressions of Domestic Electric Use

When using correlations it should be kept in mind that correlation between two variables in itself by no means indicates causation; it is a logical process rather which determines the statistician's belief that there is causal relationship between two variables and his belief as to which is cause and which is effect. Thus, where causal relationship exists in the cases shown in the following, it was known or believed to exist before correlations were drawn. But absence of causal relationship between two variables does by no means imply that they should not be correlated. Several exhibits will be shown, where the two variables are both due to a common cause. An example is the correlation between telephone and refrigerator saturation, both of which obviously depend on income.

Housing Conditions

The first group of correlations shown here is that of housing conditions or daily living and electric use. The most prominent factor in this group is the number of rooms per dwelling unit, a factor which was recognized early as an important determinant of electric use. One of the most outstanding studies in this respect has been made by the West Penn Power Company.[4]

The number of rooms per dwelling unit in itself may, of course, be affiliated with or be caused by a number of other economic or social factors. It may be, for instance, an expression of the income status of the population, with higher incomes enabling people to pay higher rents for more spacious quarters. Or, it may be a function of the size of a family. Or finally, it may be a reflection of the availability and the cost of land in the different cities.

We are, however, not so much concerned here to find the causes or conditions governing the number of rooms as we are with the relation between the statistically known measure, median number of rooms per dwelling unit, in the different cities, and a measure of electric use, because the number of rooms regardless of its causes puts a definite and physical limitation on electric use. This holds true quite clearly for lighting but it is also true as far as possession of appliances is concerned due to the lack of space in small quarters.

The correlation shown in Fig. 2 is between median number of rooms and median kilowatt-hours. The trend, which like the trends for all the following charts is mathematically determined, indicates that the relation between the two measures is quite strong, electric use increasing in nearly the same proportion as the number of rooms.

When the number of rooms per dwelling unit is combined with the number of inhabitants per dwelling unit a new measure results, *persons per room*, which is an indication of crowding. Such a measure is of great social importance, excessive crowding being considered as a concomitant of poverty and a great social evil. The measure chosen here is the per cent of dwelling units with more than one person per room and it is correlated with the per cent of consumers using less than 20 kwhr (Fig. 3). It shows that cities which have more crowding also have a larger number of small users.

Another housing measure correlated with electric use is home ownership (Fig. 4). This correlation is very pronounced and shows that home ownership is strongly associated with higher electric use. On the surface it may seem as if home ownership would exert its

[3] Housing conditions conceivably may in some communities limit the ultimate development of electric water heaters, which depend almost exclusively on one and two family houses. But nowhere has such a limit even been approached. Nor is it implied that a community with more high incomes or more homes owned does not constitute a better market for electric ranges, but these factors are practically negligible at the present development of the range and water heater markets.

[4] "*Electric Light and Power*," March, 1934.

SOCIAL CHARACTERISTICS AND ELECTRIC USE

FIG. 8 FOREIGN-BORN POPULATION AND RESIDENTIAL ELECTRIC USE

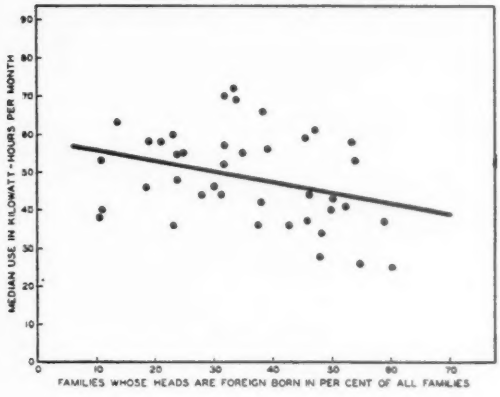


FIG. 9 THREE OR MORE WORKERS PER FAMILY AND RESIDENTIAL ELECTRIC USE

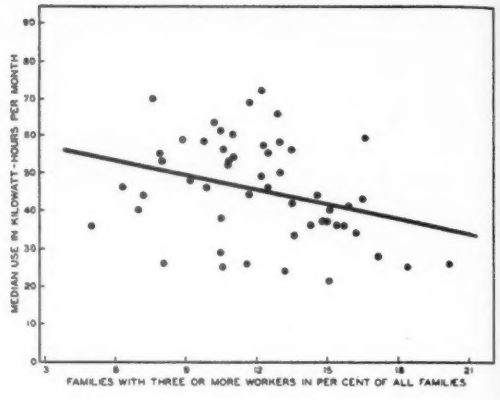


FIG. 10 WOMEN GAINFULLY OCCUPIED AND RESIDENTIAL ELECTRIC USE

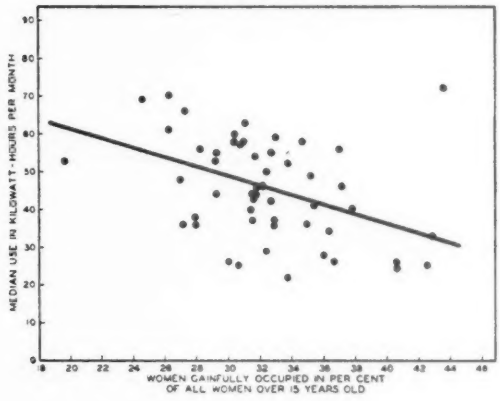


FIG. 11 INFANT MORTALITY AND LOW-USE RESIDENTIAL CUSTOMERS

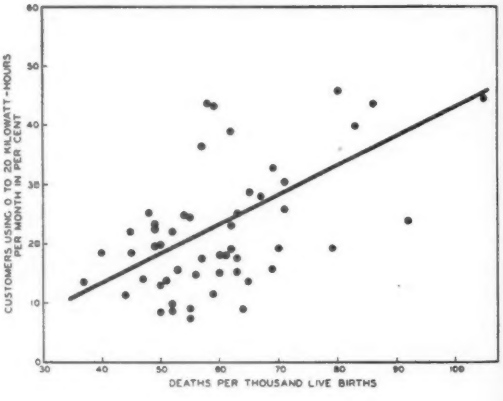
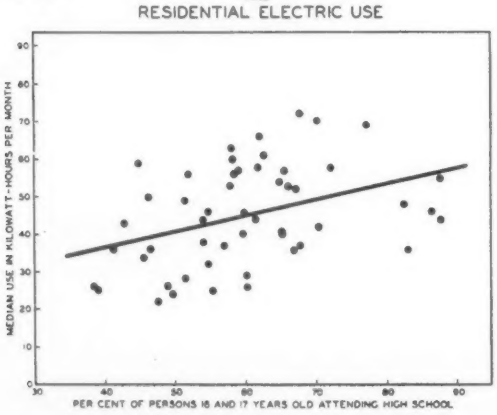


FIG. 12 HIGH SCHOOL ATTENDANCE AND RESIDENTIAL ELECTRIC USE



influence on electric use only through the medium of number of rooms. There is indeed a correlation between the two measures, that is, with a larger proportion of home ownership the median number of rooms becomes higher in the different cities, but this relationship does not exhaust the question of effect of home ownership on electric use. Many an appliance survey has revealed that certain appliances like washing machines and ironers are typical home-owner appliances, not to speak of electric ranges and water heaters. Nor is home ownership just another expression of income. In fact it has been found that income has only a slight influence upon it.[5] Thus, home ownership must be recognized as a factor affecting electric use independently of the number of rooms and income.

The next major measure of housing conditions, correlated with electric use, is per cent of apartment house dwellers (Fig. 5). Apartments are defined as dwellings with more than two dwelling units. Thus the well-known three-decker typical of New England towns is included as well as the multiple family apartment house with several hundred units in New York City, covering therefore quite a wide range. It may appear that per cent apartment house dwellers is a complement to per cent home owners. This, however, is not the case because people renting a single family home or half of a two-family house are not included in either measure. Southern cities prove to be disturbing to the correlation between per cent apartment house dwellers and median electric use because in these cities the colored population in the low income levels does not live in multi-family tenements but rather in rented single family shacks. The southern cities show comparatively low percentages for families living in apartments and at the same time low electric use. For this reason they were eliminated from the correlation which for all other cities shows a declining use with an increasing percentage of apartment house dwellers. Similarly, as in the case of home owners, the percentage of apartment house dwellers acts on electric use through the number of rooms, but what holds true there also holds true here; namely, as home ownership stimulates electric appliance ownership so apartment living is putting definite limitations on electric use quite independently of the number of rooms. To see this, one has only to compare the load building possibilities in a five-room apartment with those for a five-room house.

A further measure in the group of housing conditions is the duration of occupancy of less than two years. This measure which applies to all quarters, rented as well as owned, reflects the ratio of renters to owners, with rented quarters showing shorter duration of occupancy. But there is the possibility that two cities having the same ratio of rented to owned quarters still would show different mobility. Greater mobility as expressed by the proportion of homes occupied by their present occupants less than two years is certainly not very conducive to appliance ownership. The correlation in Fig. 6 indicates that the higher the per cent of dwellings with a duration of occupancy of less than two years the higher the percentage of consumers using less than 20 kwhr.

The last measure belonging to the group of housing conditions to be correlated with electric use is the per cent of dwelling units renting for less than $20. (Fig. 7.) This measure, in spite of the fact that it is unadjusted for differences in purchasing power of the rent dollar in the various cities is important as an indication of low standard housing, associated with low income levels. It is correlated with per cent of consumers using less than 20 kwhr as an expression of low electric use. The chart demonstrates that low electric use is associated with low rents.

Social Characteristics

The second group of measures whose affiliations with electric use are explored are those classified as social characteristics or population traits.

Various studies made in metropolitan areas with large foreign born populations have revealed a tendency for lower electric use among these groups. This cannot be ascribed exclusively to their usually lower income status, but must be due to psychological traits which make them more reluctant to adapt themselves to the more mechanical amenities of modern American life. Southern cities have been eliminated because of their large negro populations which, though native American, are either low users or do not use electricity at all. The correlation (Fig. 8) shows lower electric use with higher percentages of families whose heads are foreign born.

As mentioned above, a correlation between number of persons per family proves unsuccessful, due to the fact that the bulk of the values ranges only from 3.8 to 4.2. The same holds true for persons gainfully occupied per family, in which case the majority of the points falls between 1.65 and 1.90.

Two other measures, however, which are related to the number of persons gainfully occupied per family: namely, per cent families with three or more workers and women gainfully occupied in per cent of all women, correlated well with electric use. Both measures indicate a situation where the income of the chief breadwinner is not sufficient or stable enough to support the family and where supplementary income is needed. But the absence of two additional persons from home, or the going to work of the housewife and other female members of the family, is restricting home life to a considerable extent and depresses electric use, as Figs. 9 and 10 show quite clearly.

In Fig. 11, infant mortality is correlated with the percentage of consumers using less than 20 kwhr. High infant mortality is concomitant with a low standard of living and poverty. It is not surprising to see it vary along with the percentage of low-use consumers.

The last measure in this group is high school attendance in per cent of all persons 16 and 17 years old. As in the case of infant mortality, there is no causal relation between high school attendance and electric use. But high school attendance is rather an expression of greater well-being or a higher economic status of the population. In addition, it probably also means a higher cultural level which may have a considerable influence on the use of electricitiy. The correlation is between high school attendance and median use (Fig. 12). The trend is upward with larger high school attendance paired with higher electric use.

Income

Income is recognized as one of the chief determinants of electric use. Its prominence among the many factors has been amply stated in the literature on domestic use.[6] The relation between income or purchasing power and electric use operates not so much through the price of electricity, as through the purchase of the means of utilization of electric energy. This is illustrated by the fact that the existing investment—at reproduction cost — in electric household

[5] E. L. Thorndike, "Variations Among Cities in Per Capita Income," *Journal of American Statistical Association*, September, 1937.

[6] S. M. Hall, "Rent and Income Fix Appliance Markets," *Electrical World*, November, 1936.

INCOME AND ELECTRIC USE

FIG. 13 INDUSTRIAL WAGES AND RESIDENTIAL ELECTRIC USE

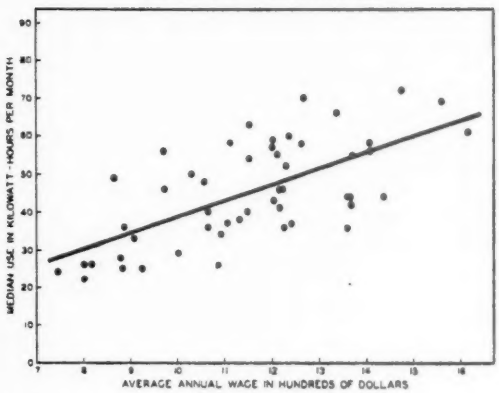


FIG. 14 INCOME TAX PAYERS AND RESIDENTIAL ELECTRIC USE

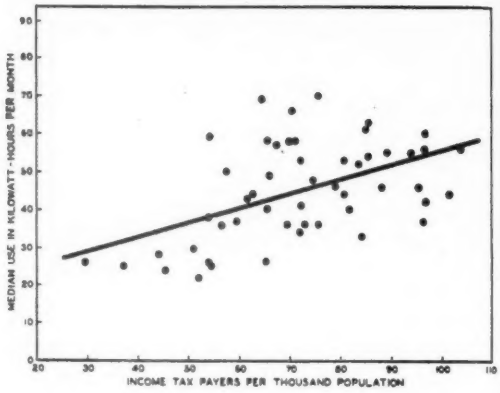


FIG. 15 NEW CAR SALES AND ELECTRIC REFRIGERATOR SATURATION

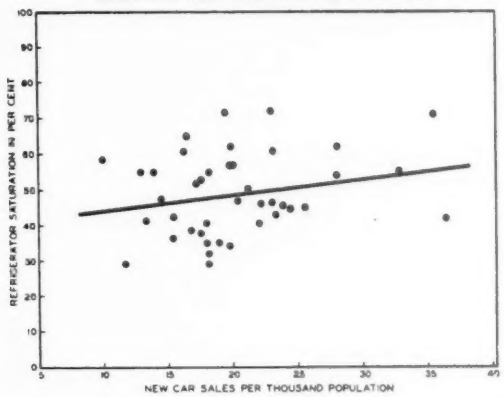
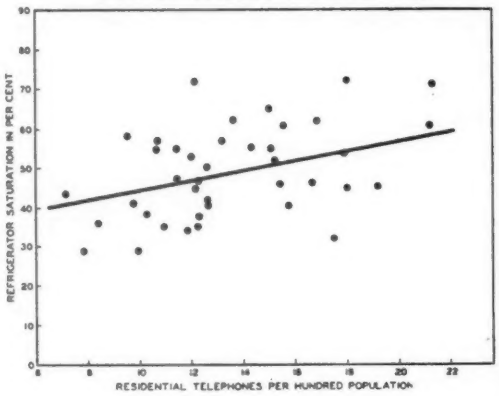


FIG. 16 RESIDENTIAL TELEPHONES AND ELECTRIC REFRIGERATOR SATURATION



MISCELLANEOUS CORRELATIONS

FIG. 17 TEMPERATURE AND ELECTRIC REFRIGERATOR SATURATION

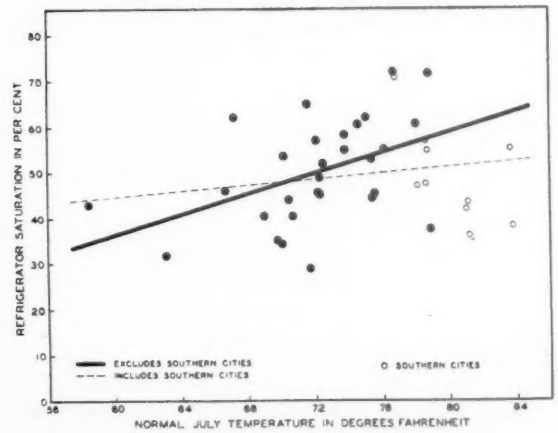
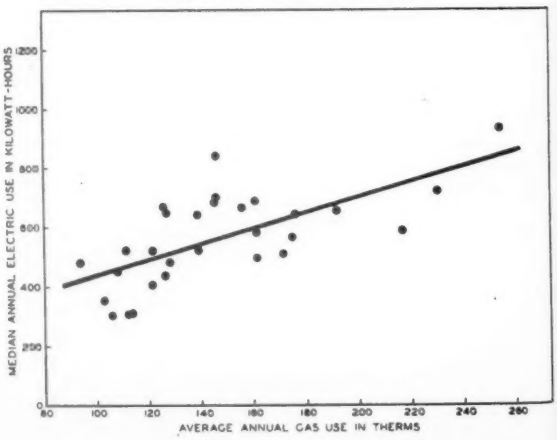

REFRIGERATOR SATURATION IN PER CENT
EXCLUDES SOUTHERN CITIES
INCLUDES SOUTHERN CITIES
O SOUTHERN CITIES
NORMAL JULY TEMPERATURE IN DEGREES FAHRENHEIT

FIG. 18 RESIDENTIAL GAS USE AND RESIDENTIAL ELECTRIC USE



appliances in 1937, without wiring costs, amounted to about $5,500,000,000, and that the expenditures for utilization equipment in this one year were $1,310,000,000, while the cost of electric service amounted to $780,000,000.

To investigate the relationship between income and electric use, the ideal measurement, of course, would be the median income for the different cities which presupposes a frequency distribution. However, such income distributions as are available at present do not cover the whole range of incomes, from millionaire to relief recipient, nor are they given for a sufficient number of cities. Because of lack of true and perfect measurements of income one has to resort to indicators or symptoms of income which themselves may be dependent upon other features of a city than income of its residents, or one must choose measures which represent only part of the income, such as wages of industrial wage earners, or per cent of federal income taxpayers.

When industrial wages are correlated with median electric use (Fig. 13) a fairly strong correlation results clearly demonstrating that higher electric use is associated with higher wage incomes. The fact that in the cities studied the percentages of all wage earners employed in industry may vary is probably of small consequence because industrial wages are usually representative of wage levels in general. Of course, these wages are dollar wages and not real wages; that is, no allowance is made for difference in value of money or purchasing power. Adjustments are not made because cost of living data are available for only a small number of the cities used here. However, the range in the cost of living between the lowest and highest city is not more than 20 per cent, while the range of wages is 100 per cent, so that any adjustment of wages for the cost of living would alter the picture very little.

Another indicator of income is the number of federal income tax returns per thousand of population which, quite in contrast to industrial wages, is a measure of the higher income levels. The correlation between it and median electric use (Fig. 14) shows that there is a correspondence between the two measures. It is interesting to note that W. J. Crowley and C. H. Baily in their article, "The Relation of Electricity Consumption to Purchasing Power," have found income tax returns the most satisfactory indicator of purchasing power. Also W. M. Persons in his article, "Influence of Climate and Rates on Electric Refrigerator Sales," successfully correlates this measure with refrigerator saturation.

Residential telephones and automobiles are frequently compared with electric appliance saturation, particularly refrigerators, since they can be regarded as the most outstanding indicators of the American standard of living. When dealing with statistics on automobile ownership, it was found that passenger car registration in the various cities is not a good indicator of income due to the inclusion of used cars. Correlation between car registration and electric use does not turn out to be very successful. However, when new car sales were used the correlation improved.

Instead of showing the correlation of new car sales and residential telephones with residential electric use, the correlations between these two measures and electric refrigerator saturation are used (Figs. 15 and 16) because they are somewhat better. That refrigerator ownership should increase with new car sales as well as with telephones should be expected as all are governed by income.

Miscellaneous Correlations[7]

Following W. M. Persons' study on the influence of temperature on refrigerator saturation for the 48 states, it was decided to investigate this influence for the cities with more than 100,000 population. The findings coincide with Persons' conclusions that with increasing normal July temperatures refrigerator saturation increases (Fig. 17). There are two trends shown in this chart: one for all cities, another one—much steeper—exclusive of southern cities. It will be remembered that the values for refrigerator saturation have been adjusted for unwired homes—a necessity if the figures are to have any meaning in exploring socio-economic causes of electric use in different cities. This, however, emphasizes the lower social and economic status of most of the southern cities which counteracts the effect of temperature on refrigerators; hence the lower trend when the southern cities—designated by open dots—are included.

[7] Other factors which have been correlated with domestic electric use are: Average value of homes, city taxes per capita, assessments per capita and retail sales per capita. None of these correlations proved successful. Value of homes, besides being based on the 1930 Census, could not be expected to correlate well because of the varying proportions of families owning homes in the different cities. City taxes and assessments are probably too much affected by differences in the efficiency of city administrations and the inclusion of industrial and commercial properties in assessment values. Retail sales per capita, another item investigated, also proved unsuccessful, probably because of purchases made by non-residents.

The last correlation (Fig. 18) is between gas and electric consumption. W. J. Crowley and C. H. Baily have observed, in their study of Illinois communities, a close correlation between gas and electric use. This may at first seem paradoxical in view of the fact that gas and electricity are competitive in respect to cooking, water heating and refrigeration; but the use of the median electric kilowatt-hour consumption in this study eliminates the effect of electric cooking and water heating, whereas, as far as the average gas consumption is concerned, the changing of a number of gas consumers to electric cooking would not affect the average gas consumption to any appreciable extent. House heating consumption is not included in the gas figures employed here. The correlation permits the inference that if gas and electric consumption—below the zone of actual displacement of one by the other—vary together in the different cities, regardless of rate levels, there must be a common cause, namely, the economic situation which is acting simultaneously on both.

Critique

The results of this study having been presented, we shall now try to appraise them. First of all, certain limitations and shortcomings of the basic statistical material must be pointed out. The lack of complete coincidence between city area and company supply territory in many cases represents one of the major defects in the correlations and part of the scatter of the points about the trend line must be ascribed to this condition. Next is the lack of up-to-date data. Whereas company statistics are all for the year 1938, this is not the case with the various socio-economic factors. A large part of them originates from the 1930 census of population, for instance, social characteristics and some of the housing conditions. Several of the latter originate in the 1934 Real Property Inventory, such as number of rooms, crowding and duration of occupancy. Industrial wages and income taxpayers are for the year 1937, while only new car sales and telephones are for 1938.

But the presence of these inadequacies in the statistical material enhances the effectiveness of the evidence produced rather than diminishes it.

It will be remembered that for eight of the seventeen measures which were correlated in the foregoing, the correlation with electric use did not represent causal relationship. They are duration of occupancy, crowding, low rent, infant

mortality, high school attendance, new car sales, telephones and gas use. Seven of these are themselves caused more or less by income, while short duration of occupancy is a characteristic of apartment house living.

Why then have these measures been introduced at all? First of all, some of them—like high school attendance and infant mortality—have elements other than income in them, i.e. characteristics of the personnel which are more of a cultural or racial than of an economic type. Second, by bringing in these additional measures the possibility of chance correlations—a danger always present where correlations are used—is eliminated and thus the evidence is strengthened.

Now, the statistical appraisal of the results: The trends for all the correlations shown have been mathematically calculated by the method of least squares. The coefficients of correlation which are a measurement of the dispersion of the points and the steepness of the trend, have also been calculated and were found to range from 30 per cent to 70 per cent, with 100 per cent representing perfect correlation. About this rather intricate statistical measurement it should be said that, depending on the size of the sample, even a 20 per cent correlation can be significant.

In our case the size of the sample is always considerable. Starting out with 94 cities above 100,000 population, the smallest number of points in any correlation is 30, with 52 the highest, the loss of the other points being caused by non-availability of data or elimination due to lack of coincidence of city and utility territory. On this score the significance of the results cannot be doubted.

There are, however, other considerations. It must be realized that electric domestic use is a product of many various factors without any particular factor being dominant; even in the socio-economic sector, which is only one of the several which should be considered, the individual measures introduced in the foregoing should be visualized as acting together. Their effect, however, is not always cumulative. They may sometimes counteract or even cancel each other. It may be, for instance, that for one city the number of rooms is low while industrial wages are high, the first tending to lower, the second tending to raise consumption.[8] This, of course, is responsible for most of the dispersion of the points about the trend, in addition to that caused by the shortcomings of the data, as described above. Under these conditions a perfect correlation cannot be expected.

[8] There is a statistical means for combining several factors; namely, multiple correlation. However, with a great number of factors the operations become very lengthy. Using three factors it was possible to obtain a coefficient of correlation higher than that of any of the components.

Conclusions

To sum up the results, we may focus attention on six correlations which stand out as particularly significant among the seventeen shown. Two of them, number of rooms and home ownership, emphasize the strong influence of housing conditions on intercity variations of electric use. Two others, foreign born and women working, bring out the effect of social characteristics and, finally, the last two, industrial wages and income taxpayers, demonstrate the importance of income. Reviewing these three pairs of measures, we become aware of the fact that the three groups mentioned here constitute three subdivisions of the social and economic sector which are relatively independent of each other and that they are fundamental in their effect on electric use.

The fact that the various socio-economic factors can be successfully correlated with residential electric use in the larger cities of the United States in spite of wide variations in rates and pres ably in promotional efforts on the p of the companies, attests to the imp tant part played by these factors in residential demand for electricity.

This does not mean that rates, most widely discussed determinant electric use, are ruled out, but it d mean that the so-called "elasticity of residential demand for electricity" (relationship between unit price and quantity of electricity) is far from s ficient to explain the variations in r dential use in the larger cities of United States.

Facts such as that two cities w widely different rates have the same e tric use, or that two cities with sim rates have widely different uses—e such examples are easily found—can be explained without the effect of ferences in number of rooms, in ho ownership, in population characteris or in income.

(The author wishes to give acknowle ment to the following members of the vey Division of the Bureau of Econo Research who have assisted in the co tion, compilation and analysis of the m rial contained in this paper and in presentation and discussion of the res Messrs. Abrahamson, Dettman, Diehl, J son, Pagella, Plant, Scheerer, and Zano

Charting the Course of Accident Prevention

(*Continued from page* 35)

the job. The Philadelphia Electric Co. is doing excellent work along this line. See Dr. Viteles' article in the BULLETIN of July, 1942.

3. Improvement of training methods. This includes making safety training an integral part of job training. Also general safety education and development of rules and procedure. Commonwealth Edison, Consolidated Edison, Duquesne Light and Pacific Gas & Electric are companies who, to the writer's knowledge have been doing outstanding job training work.

4. More attention to the health and well-being of the individual employee (mental, moral, and physical state of being); including attention to developments of proper attitude toward safety on the part of employees.

5. Improvement in supervision. Recognition on the part of supervisors that safety is their responsibility and can't possibly be assumed by a safety department. The article by Mr. H. O. Sprinkle "Utility Safety Program Which Brought Results" in the BULLETIN of August, 1942, should be "must" reading supervisors and higher executives.

6. A corollary to the above: Pro supervisors with the proper train tools, and "ammunition" commensu with their safety responsibility.

7. Continued emphasis in proper sign, methods and equipment and c tinual and thorough inspection.

8. And yes, I'll say it—more and ter statistics. So we'll know what w been doing, how we stand and in w direction we should move.

Recognizing its "integralness" with al dustry and its social obligations to help ate "the better world" the utility ind has always been in the forefront of the s movement, not only with respect to "clea its own house," but in all community, and national activities concerned with sa The industry must continue its good with even more intensity of effort to c a better record within itself and give gr help in solving the national problem.

In the face of annual fire loss to the try of $314,849,000 and a record of 100,000 accidental deaths, nearly 10,00 accidental injuries and countless pre hours lost annually when every person every person injured and every hour l a retardant to the winning of the wa question should not be "What is to be d but rather "What's holding us back?"

What a Group of Connecticut Business Men Are Doing About Taxes

By Charles L. Campbell

President, Connecticut Light and Power Company and Chairman of Board Connecticut Public Expenditure Council

"WHAT can we do about taxes?" I have asked myself that question with increasing frequency during the last four or five years. It bobbed up again and again, and I was greatly disturbed because at first there seemed to be no adequate answer. But since worrying about a problem seldom serves any constructive purpose, I read up on the subject, talked it over with my friends, and gave it some quiet thought. Gradually it appeared that something *very constructive could be done about taxes*. But before we get into that, let's see just why I and thousands of other business men had cause for deep concern.

As a plain American citizen, I shared the misgivings of millions of other people over the mounting costs of government. It was only too clear that what all governmental units in the country were spending had to be paid for eventually by all the citizens for whom it was spent. If a handful of people chose to believe the long-hairs who fatuously argued that a debt wasn't a debt "because we owed it to ourselves," that was their misfortune—I was one of the 130,000,000 people who knew too well who had to carry the freight. We were all going to be tapped—roughly speaking, in proportion to our individual ability to pay, and to the amount of goods we each consumed and the services we utilized. So, like every other American, I had a strictly personal interest in the total amount of public expenditures, whether for leaf-raking, protecting my home from burglars, delivering mail to my door, or whatnot, because in the end I had to help foot the bill.

As the responsible head of an important Connecticut industry I had to look at the tax problem from another and non-personal view. In my capacity as President of the Connecticut Light and Power Company, I am obliged to protect the interests of the 270,904 customers who depend upon us for service, the cost of which must include the taxes that we have to pay. The same condition applies, of course, to every other public utility in the State. In addition to this I have an obligation to protect the interests of the 19,600 people who own our company—the shareholders. In this respect I am no different, I suppose, than the heads of the 470,000-odd business corporations throughout the country, almost all of whom have been faced with the growing reduction of corporate income-after-taxes. As a matter of fact, the business corporations of the country, *taken as a whole,* lost money every year between 1930 and 1939. Fewer than half of them, or about 200,000, have shown any profit at all during the past few years. Every business man knows that the ratio of profit to taxes became smaller and smaller within the last decade, and there is every indication that the present course will become more pronounced within the immediate future.

I refer, of course, to the war, which will be won however high its cost may run. The prosecution of the war is placing unprecedented burdens upon all of us which are cheerfully being shouldered. My chief concern lies, *not with the cost of the war,* but with the cost of those other governmental services which makes it doubly hard for you and me to pay for the war. Federal expenditures for non-war functions are currently $6 billions a year, of which $2 billions are considered nonessential by Senator Harry F. Byrd, Chairman of the Joint Committee on Reduction of Nonessential Federal Expenditures. State and local government cost us approximately $10 billions more, and heaven only knows how much of that is nonessential. It's pretty clear to me that governmental spending—federal, state, and local—is still on the prewar, business - as - usual scale.

A situation like that just doesn't make sense. In a storm, good sailors trim sail. During the Depression, well - managed business cut out the frills. But in the face of what is admittedly the gravest crisis which has ever confronted our country, government goes blithely along at a pre-war pace.

How could we make government tighten *its* belt, too? How best to encourage efficiency, discourage waste, put a premium upon extravagance, and place the government which you and I pay for on a businesslike basis?

A small group of Connecticut businessmen, including myself, turned for advice to Mr. Lewis H. Brown, President of Johns - Manville Corporation, and Chairman of the Tax Foundation. Mr. Brown generously consented to come up from New York to talk with us, and at a dinner meeting held in Hartford in December, 1941, discussed the tax problem before more than 100 representative Connectitcut business and civic leaders. He pointed out that governmental fiscal and administrative operations could and should be put upon a businesslike basis. To do this it is necessary to work with facts, not with opinion, he said. First you have to get the facts, then interpret them, and then translate them into terms of improved efficiency and decreased waste. Specifically, he advised that local thinking and initiative make itself responsible for the creation of an organization that could do the job at hand.

A temporary organization was formed on the spot. They elected me chairman pro tem; and we spent the following six months laying the necessary groundwork. On June 30, 1942, the Connecticut Public Expenditure Council was formally organized, with myself as Chairman, Robert B. Newell, President of the Hartford National Bank and Trust Co., as Treasurer, and Frederick R. Coles, Vice President of the same institution, as Assistant Treasurer.

I feel that we are particularly fortunate in the caliber of men who comprise the Council's Executive Committee. Fuller F. Barnes, President of the Associated Springs Corp., of Bristol, is an acknowledged leader of that community. Both George W. Berger, President of the Berger Bros. Co., and Allerton F. Brooks, President of the Southern New England Telephone Co., have long been identified with civic undertakings in their home city of New

Haven. John B. Byrne, President of the Hartford - Conn. Trust Co., was formerly State Banking Commissioner. C. K. Davis, President of the Remington Arms Co., of Bridgeport, is a prominent industrialist with a reputation for getting results. Peter M. Fraser, Vice President of the Conn. Mutual Life Insurance Co., Hartford, is widely known for his active interest in organizations devoted to Hartford and the State. The President of the Aetna Insurance Co., W. Ross McCain, was President of the Hartford Community Chest, has been an Executive Director of the Chest ever since 1933, and has always displayed a deep interest in civic and State matters. William J. Pape, President, Waterbury Republican-American, could, if he were not too modest, truthfully lay claim to distinction as a member of Connecticut's Fourth Estate. A New Britain member of our Executive Committee is R. E. Pritchard, who is President of The Stanley Works of that city, one of the largest manufacturing concerns in Connecticut, and who has been identified with many civic movements in the State. Evarts C. Stevens, President of the International Silver Co., Meriden, is well known throughout Connecticut for his active interest in civic matters in the communities in which his company has its factories.

From the very beginning, it was decided that the Council would never concern itself with partisan politics, but would extend friendly help and counsel to any and all public officials, without regard to their political affiliation.

The members of the Executive Committee and I had realized all along that the success of the Council would pretty largely hinge on the man who would be chosen to carry out its policies. Primarily, he should be a man of character and of sound judgment. He should be trained in government work; well-grounded in research; familiar with statistics and government finance; and be an able administrator. Under our very noses we found such a man in Carter W. Atkins, who during the past four years had served as Director of Hartford's Governmental Research Institute. Mr. Atkins has been identified with government research during most of his working life, and in his field is nationally and favorably known. We are confident that Mr. Atkins will capably carry out the activities authorized by the policy-making groups—the Executive Committee and Board of Trustees.

What is the Connecticut Public Expenditure Council set up to do? It is geared to bring about an improvement in the financial and administrative operations of state and local government in Connecticut, and, by implication, in the Federal government. How will it accomplish this? By sincere cooperation with public officials, by fact-finding, and by making known to the public the results of its research.

If practical suggestions by the Council were to result in a substantial saving in the purchase of public equipment and supplies, in the reduced operating cost of such equipment, in trimming the budgets of towns, cities, and the State, and in curbing all public expenditures which are not completely necessary to the war effort and the well-being of the public I should say that it was doing a good job. I should say further that it [illegible] justifying the moral and financ[illegible] support accorded it by 400 memb[illegible] throughout the State, and the time [illegible] thought and energy freely given by [illegible] busy business men who comprise [illegible] Board of Trustees and the Execut[illegible] Committee.

One of the things I like best ab[illegible] the Connecticut Public Expendit[illegible] Council is that it *is* democracy at wo[illegible] A group of citizens get together [illegible] set up a working plan to make eve[illegible] body's tax dollars go farther. They [illegible] it by digging out the facts, resolut[illegible] refusing to play politics, publicizing [illegible] results of their findings, and laying th[illegible] cards on the table. It appeals to [illegible] so much that I'm glad they elected [illegible] to head up the organization.

Reports of Joint Subcommittee

(*Continued from page 62*)

tions between noise magnitude and noise transmission impairment.

Report No. 46—Susceptiveness of Subscriber Station Sets. This report summarizes the results of measurements of the inductive susceptiveness of subscriber station apparatus employed in the Bell System. The basic data are presented in a series of curves of single-frequency ratios of receiver current to voltage to ground on the various station sets. For convenience in estimating receiver noise due to station set unbalances from analyses of noise to ground in specific noise problems, values of receiver noise (in db) per volt to ground have been tabulated for a number of sets for harmonic frequencies of 60 cycles in the range from 180 to 2700 cycle. In addition, a comparison of the susceptiveness of a number of the more common station set arrangements is given for composite-frequency noise to ground. The receiver noise values given for the 557 and HAl receivers have been adjusted to correlate with the 144-type receiver noise transmission impairment scale.

Report No. 47—Positive Disconnection of Distribution Circuits During Faults to Ground. The results of a study of means for insuring positive disconnection of distribution circuits during faults to ground are described, particularly from the standpoint of coordination of telephone facilities which are jointly supported on the same poles with the higher voltage distribution circuits. The report includes a brief discussion of important factors involved in providing protection for telephone circuits dur[illegible] contacts with distribution circuits, a c[illegible] sideration of the factors involved in [illegible] plying ground relaying to distribut[illegible] circuits, the results of extensive osci[illegible] graphic observations on the charac[illegible] istics of distribution circuit ground fa[illegible] and the performance of distribution [illegible] cuit protective devices, as well as a nu[illegible] ber of other matters which have a be[illegible] ing on the problem of deenergizing [illegible] tribution circuits under ground-fault c[illegible] ditions.

Report No. 48 — Low - Frequ[illegible] Shielding In Telephone Cables. T[illegible] report replaces those parts of Engin[illegible] ing Report No. 26 which give meth[illegible] of calculating shielding in teleph[illegible] cables, and presents methods and m[illegible] rial whereby a large variety of shield[illegible] problems involving short cables may[illegible] solved graphically. In addition, data[illegible] presented for types of cables which h[illegible] come into use since Engineering Re[illegible] No. 26 was published, among these[illegible] ing coaxial cables, cables with an in[illegible] nal layer shield for carrier transmiss[illegible] and gopher-protected cables. Data[illegible] given for new manufacturing sched[illegible] of sheath thickness for lead cable, [illegible] the experimental information on shi[illegible] ing properties of tape-armored cable[illegible] been extended. The discussion is limi[illegible] to cable circuits of such length (betw[illegible] repeaters) that the effects of charg[illegible] currents associated with conductor [illegible] pacitance can be neglected.

Report No. 49 — Wave Shape

(*Continued on page 64*)

Sell Today—Deliver Tomorrow

By C. E. Greenwood

Commercial Director, Edison Electric

THE broad concept of a National Sales Program designed to siphon several billions of joy-ride spending money into channels of investment in War Savings for useful consumer goods has been the subject of academic discussion in recent weeks.

In this scheme there is really nothing fundamentally new, except in application. Many a young couple has consistently saved for the first payment on a future new home. Under the caption "Christmas Clubs" many thousands of dollars have been laid away each year to buy Johnnie and Aunt Minnie Christmas gifts. Why not lay aside savings in a Victory Merchandise Bond to buy a present for oneself in peace time?

There have been a few individuals and groups who have devised definite ways and means of putting the big idea to work and have crystallized thinking into Plans of action. No one of these plans is ready to go and the originators have their ears to the ground for constructive suggestions on how to make the whole mechanism click.

THE NUGENT PLAN

Outstanding in the published programs are the Nugent Plan, the McFall Plan, and that of Hartford Electric Light Company. Mr. Rolf Nugent is Director of the Credit Policy Division of OPA and has been on leave of absence from the Russell Sage Foundation. He poses the question "Can consumer spending be used to fight inflation." In 1943 the national income is estimated at $130,000,000,000. Personal taxes may account for $15,000,000,000, and expendable net income therefore will be around $115,000,000,000. Of this amount the normal saving is $20,000,000,000 for the nation, and $77,000,000,000 would be spent for consumers goods on the basis of present prices, which leaves a balance of $18,000,000,000 to be absorbed.

Mr. Nugent takes the justifiable position that we require more than a voluntary savings plan to direct a substantial portion of these billions into war investment channels for deferred purchase of goods to be manufactured in the future. The American people are Spenders and why not gain the objectives of investing in the war effort, assisting in helping to retard inflationary tendencies and, very important, in obtaining the benefit of organized industry selling forces in promoting greater investment by the masses in the war effort, through an immediate buying incentive.

Let us bear in mind that despite a substantial amount of war bond buying by men and women engaged in defense plants through the "10% deduction" method, there are still millions of American citizens who have not purchased any bonds. These very persons might be sold an automobile, electric refrigerator, electric washing machine, a high priced radio, an automatic heating plant or such, to be delivered in peace time when the equipment is available. Mr. Nugent points out that of course purchases cannot be allowed of goods that are now available. They should be relatively costly as well; they should have widespread demand and be produced by relatively few manufacturers.

Among the primary principles emphasized in this plan of instalment payments are the priority and discount features. When the plan is put into force, Bill Jones would start payments on a Special Bond issued by the U. S. Treasury, which would represent approximately the amount of the item he desires. As the owner of this Bond, Bill would have priority over the person who had not so invested but yet had an equivalent amount in cash in his jeans when goods were available to purchase.

On the Nugent Plan, payments would be $3 on a $100 certificate and $12 on one of $2,000. The collection agencies might be paid 1½ per cent on payments under $30 and 1 per cent over $30. It is understood that it costs the U. S. Treasury a given amount of money to sell its war bonds, and the supposition is that the cost to the Government of selling the Special issue will be about the same average as selling its Series E bonds.

The buying public now would make first payments to the dealer. The dealer passes the money on to the War Finance Company which will issue a payment book to the buyer. There is an assumption that collections can be made through the telephone companies, electric and gas utilities or Western Union as collection agencies.

Now it is quite possible that Bill Jones made payments on a $700 Merchandise Bond but the price of the car that he wanted when it could be delivered in the post-war period will be $900. He takes up the slack with his Merchandise Bond plus $200 in cash. He may have to arrange with the finance company for the extra $200 if he does not have it in the bank. The Federal Reserve Board would be responsible for calling priority numbers.

THE McFALL PLAN

So much for the high spots of the much advertised Nugent Plan. The plan of Dr. Robert J. McFall, Chairman of the Cooperative and Coordinated Marketing Committee of the American Marketing Association, has been referred to in previous paragraphs. Just a general outline of what is in the minds of this business group. The purpose is to put back pressure on inflation and "to assure labor of jobs, the public of goods, management of orders and stockholders of dividends when the war is over." Dr. McFall has presented the proposal of his committee to the Treasury Department. It would provide for a Victory Merchandising Bond to be issued like the E, F and G Bonds already offered. These bonds would assure first deliveries when the goods of the buyer's choice were turned out of the factory at a future date. This establishes a priority feature.

Dr. McFall has been prominent in market research fields and was instrumental in developing a Buying Power Index which would be applied to the Victory Bond plan to establish a base for bond sales quotas county by county. The selling job would be indicated by the excess income to be absorbed in Victory Merchandising Bonds in county areas.

The following proposals have been made to the U. S. Treasury:

"1. That, in addition to the established campaign for the sale of bonds based merely on the motives of patriotism and investment, every practicable effort be made to increase the sale of bonds by connecting them with the advance sale of durable consumer goods

for post-war delivery and, insofar as possible, on a priority basis to the buyers of bonds.

"A large part of the population is merchandise-minded rather than investment-minded; it is accustomed to buying things with its dollars; it has manifested the fact that, when goods are scarce, it will buy in advance to obtain priority of ownership.

"The sales forces of the nation are also largely merchandise-minded. They are familiar with selling goods. They are successful in selling goods.

"The factors of readiness to buy on the part of the consumer, and skill in selling on the part of the sales forces, should be used to supplement the investment feature of the present bond campaign. The element of patriotism will be equally strong in either case.

"2. That for this purpose, the U. S. Treasury make a special issue of 'Victory Merchandise Bonds' (serially numbered, registered, sold at par and carrying interest payable only when transferred for merchandise); these bonds to be sold to the public through industrial and commercial channels in so far as practicable in parallel with the advance sale of post-war merchandise on a priority basis; and to be redeemed primarily only through industrial and commercial channels which will convert them to cash at the Treasury immediately following the delivery of said merchandise to the consumers. This feature will retard the rate of cashing such bonds to the rate of actual post-war production and delivery of merchandise.

"3. That the Treasury accept the proposal for the formation of an advisory group of leaders in market research and sales experience in the furtherance of such a plan.

"4. That, in accordance with the best procedure, the pressure for the sale of bonds be apportioned to the various subdivisions of the nation on the basis of the best available quotas of sales potentials. We have already developed a County Buying Power Index as a base for the establishment of bond sales, quotas which show where the excess purchasing capacity is county-by-county. This Buying Power Index shows the retail spending capacity of people where they live, as opposed to mere retail sales, which may be accounted for by people living in a wide area. Unless such bond sales are set up on quotas in relation to capacity to buy, geographically, we may be missing potential money in hand that may be like rotten apples in the barrel."

HARTFORD ELECTRIC LIGHT PLAN

While discussion has been in progress on the organization of these National activities and the merits of "selling today for tomorrow's delivery," Yankee pioneering spirit has been at work in Hartford Electric Light Company, Hartford, Conn., and Vice President R. D. Cutler has announced their Victory Sales Plan. They're off—with an actual test among the customers served, limiting merchandise sold to electric refrigerators, ranges and water heaters. Mr. Cutler announces, however, that there may be additions later to this list.

The objectives in brief are to help convert present excess purchasing power into savings to retard inflation; an immediate investment of these "savings" into securities for financing the war effort and assistance in building up a backlog of orders which will put industry to work on civilian goods when the shooting stops.

This will help the company too. When the defense load drops, Hartford Electric, like many other utilities, will have large capacities to sell and substantial orders for electric household equipment when put to work will take up part of the slack. In the interim, while new appliances are out of sight, electricity as the foremost household servant is to be kept in the public mind. The plan stipulates the sales will be made through the dealer which will give each one more courage to keep in business and hold a nucleus of a sales force.

Enumeration of the elements of the Hartford program follows:

1. Dealers will take orders for specified appliances to be delivered as soon as available at the end of the war. Orders will provide for the estimated purchase price in round figures, with provision for discount and installation allowances on specified appliances.

2. Customers will deposit with the Hartford National Bank and Trust Co. in convenient monthly installments the funds to cover the estimated purchase price. The Company will immediately pay to dealers, who will in turn deposit in a Trust at the Bank, commissions to cover the amount of discounts and installation allowances as set out in agreements between Company and dealers.

3. Funds deposited in Bank by customers and dealers will be invested in government securities.

4. Company will pay dealer or dealer's salesman $3.00 for each approved order.

5. At end of war or when models and prices become available dealers will obtain selection orders and install the apparatus. Funds deposited in the Bank by customers and Company will then become available to dealers to complete the transaction.

6. Preference in delivery on these orders will be given by dealers, distributors and manufacturers according to increased quotas of merchandise to be assigned this territory. Customer's preference in delivery will be assigned in the order that final payments for appliances are completed.

7. Cancellation by customer with return of all funds paid in will be allowable up to time of signing selection order.

8. The expense to the Bank of handling the funds will be paid by the Company.

Now business men with vision and courage realize that thinking on the problems of winning the WAR should not exclude thinking of winning the PEACE. It is planning NOW th will bring a peace-time era of the ki for which American men are fighting an era when the banner of free ent prise must continue unfurled. That a day when business will be advertisi for salesmen once more, when magazi and newspapers will be presenting t story of the quality of the produ which free men are turning out und private management. It will be a d in the electrical industry when sales ganizations that have undergone d assimilation will be built up again to their stuff. Utility executives will c for revenue and more revenue to find margin of profit for investors in th companies, and no plan of manageme can give the answer without an effecti sales organization.

The purpose of the author is not pass on the advantages or disadvanta of the PLANS presented. The origi tors of all of them invite construct suggestions leading to refinement. fact, the National Federation of Sa Executives is distributing a questionna among its members to obtain reactions groups who would be most intimat concerned in the success of the over program.

The U. S. Chamber of Commerce fers its blessing after noting the alre pent-up demand for consumer goods now in production which is shown fr its national survey of public wan However, a local unit, the Los Ange Chamber of Commerce burst forth wi severe criticism of this "pay twice pla which they term it, pointing out t "ifs" that must come true to make su plans constructively workable.

Again, a financial writer in a N York paper gives credit to the fam ship builder Kaiser for the big idea, a believes that opposition might devel among many manufacturers for this v reason.

First and foremost is the action of t U. S. Treasury Department. If the p sibilities of the SELL TODAY—D LIVER TOMORROW program absorb stupendous excess spending m gins into war financing channels, and put a brake on inflationary tendenc appear favorable, and the Treasury sues a Victory Merchandise Bond some other "special" for the purpose investment, workable adjustments in d tails will follow. Once the green-li is flashed, one can expect short delay the motivation of utility-dealer sales o ordinated plans in the electrical indust

A Survey of Opinion from a Cross-section of American Industry

on the

Value of Good Lighting in War Production

Abstracted from a report of the Illuminating Engineering Society

SCIENTIFIC research has determined what constitutes good lighting for industrial production. The proof of the pudding, however, lies not in the recipe but in the eating. Accordingly, the Illuminating Engineering Society, early in 1942, appointed a committee* to canvass personally a substantial cross-section of American war industry for the purpose of finding out what men responsible for increasing war production thought they secured from improved lighting. The field investigation, covering the industrial areas in New England, South East, Ohio Valley, Great Lakes, Mississippi Valley and Pacific Coast, was made by teachers of illuminating engineering at Case School of Applied Science, Columbia University, University of Illinois, Stanford University, and the University of Tennessee. Assisting these investigators were consultants in the fields of color, science and journalism.

In all, 82 factories were visited. The reports of the investigators covering every visit are listed in case studies, not published in full here, but available for further study upon request. The report embodies a summary of the statements on the value of light to war production made by those interviewed who were responsible for running war industries. For obvious reasons the identity of plants visited and people interviewed cannot be disclosed, but the character of the operation and the occupation of the persons contacted are described in the reports of the investigators.

The plants visited were engaged in various war industries including aircraft assembly and parts manufacture, ordnance, shipbuilding, machine tools, steel, electrical equipment, motor trucks and tractors, meters, metal hose, paints, lamps, hardware, cable, castings, insulators, textiles, valves, plastics, Diesel engines, canning, and miscellaneous metal parts for precision operations.

In most cases the plants visited were not new—only the lighting was new. In several new plants the workmen had just come from an old plant owned and operated by the same management. Thus, the investigators were able to get opinion based upon current experience.

While this is a survey of opinion only and is not published as an engineering report, the very mosaic of opinion from various industries differing as to size, location and kind of operations, is the circumstantial evidence that establishes the fact.

However, to reinforce these opinions there are included brief statements of results that have been found in controlled laboratory experiments. These findings are exact and so confirm the consensus derived from this cross-section of opinion.

The Committee wishes to thank those who gave so freely of their time to the interviewers. That in itself was evidence of the great interest that industrialists are taking in improved lighting practice.

HOW BETTER LIGHTING INCREASES WAR PRODUCTION

- Increases the accuracy of workmanship.
- Reduces spoilage and consequent rework.
- Speeds seeing — people actually see faster.
- Makes seeing easier—conserving human resources—aids old and defective eyes most.
- Lessens eyestrain and fatigue.
- Enables better utilization of floor space.
- Aids in keeping plant clean and neat.
- Improves labor conditions — people prefer to work in a well-lighted plant.
- Promotes safety—crippled workers are out of the war as wounded soldiers are.

ACCURACY OF WORKMANSHIP

Laboratory Findings

Ability to see small details increases as illumination increases. Light is a magnifier of small detail. If a given object can be just identified under an illumination of one footcandle, a similar object about *half* the size can be identified with the same ease if the illumination is increased to 100 footcandles.

Field Opinions

A *motor truck* manufacturer states his workmen can read micrometers and scales on machines more accurately and quickly under new improved lighting. A similar statement was made by an *aircraft parts* manufacturer.

A manufacturer of *heavy aircraft parts* reports inspection more efficient and production increased when lighting was improved (to 40-50 footcandles). Tool marks were easily seen and file marks revealed under the new lighting.

A *hardware* manufacturer reports shell fuse production increased 25 per cent with better lighting, and on some items 50 per cent. This was due to more efficient machine operation and better inspection of work in progress as a consequence of better seeing conditions.

A *general machine shop* is installing 65 footcandles in a new section because it finds it necessary for precision work.

A manufacturer of *precision thread-cutting tools* states that good lighting is essential for precision work at night.

An *electrical equipment* manufacturer reports that when lighting was improved, there was a five per cent increase in production; also, better work turned out.

A manufacturer of *can-making machinery* says inspection is improved with high-level illumination. Also, color quality of new lighting is better for reading blueprints.

A *cannery* reports that with better lighting it is now easy to see imperfections in fruits more quickly and accurately.

A manufacturer of *tags and labels* reports that with improved lighting a much better and more accurate color-matching job is being done.

A *textile* manufacturer states that better lighting aids greatly in color matching. A similar comment was made by a large *hosiery* manufacturer.

A *tobacco processor* reports that new improved lighting aids greatly in the selection of tobacco because of color and freedom from shadows.

A *motor car* manufacturer reports slight changes in shades of paint now readily detected under improved light.

* L. H. Brown, H. B. Dates (Chairman), A. D. Hackley, K. B. Jackson, J. O. Kraehenbuehl, Dr. Matthew Luckiesh, R. C. Putnam, E. H. Wakefield, S. B. Williams.

LESS SPOILAGE

Laboratory Findings

When a glare source was located within five degrees of the line of vision, 84 per cent of the light on the test object was wasted due to the presence of the glare source. As the glare source was raised from the horizontal line of vision the waste of light decreased, but 42 per cent was still wasted when the glare source was 40 degrees above the line of vision.

Field Opinions

A *roller bearing* manufacturer states that since lighting was improved (level raised from 15 to 45 footcandles) grinder operators spot improper grinder performance more quickly and can correct this before the work is spoiled.

One *electrical equipment* manufacturer reports spoilage reduced with better lighting. Another similar manufacturer states that better lighting was accompanied by a five per cent reduction in errors.

General reduction in amount of work spoiled brought about by better lighting is reported by a wide variety of manufacturers, including such products as: *intricate aluminum castings, electrical equipment, automatic machine tools, valves, labels and tags, motor trucks and hardware.*

A large manufacturer reports a reduction in *office* errors when lighting was improved.

In *tobacco processing* it is reported that defects in wrapping are detected more quickly with better lighting.

An *automobile* manufacturer reports fewer errors in mixing paints in spray booths when lighting was improved, and also that improved lighting in body trimming area and spray booths resulted in such improvement that installation paid for itself in approximately a year.

FASTER SEEING

Laboratory Findings

It takes time to see. Tests show that as illumination is increased from one to 100 footcandles, speed of seeing is practically doubled.

Field Opinions

A *valve* manufacturer finds his men can read verniers more quickly with better lighting. Resultant overall increase in production was 25 per cent.

A *heavy machine tool* builder says that better lighting reduces the time required to rebuild a machine. Another manufacturer specializing in *machine tool rebuilding* reports the same fact.

An *electrical equipment* manufacturer reports that with improved lighting the time for machine set-ups is reduced.

A *cannery* reports that the production of a night crew now equals that of the day crew since better lighting was installed.

An *aircraft parts* manufacturer and a maker of *electrical equipment* both report that with improved lighting there is less time lost by workmen hunting for tools.

A *steel spinnings* manufacturer states that when lighting was increased (from 30 to 110 footcandles) imperfections were much more quickly detected, and production has been increased.

GREATER EASE OF SEEING

Laboratory Findings

Better illumination aids the individual in performing visual tasks. In one comprehensive series of tests, those with better eyes were aided 14 per cent by better lighting, while those with most defective eyes were aided 22 per cent. Surveys indicate that 40 to 60 per cent of workers in industry have defective vision.

As people grow older the prevalence of defective vision in their age group increases, and the flexibility of the eye muscles decreases. A recent eyesight survey among industrial workers (published in Archives of Ophthalmology) states that for workers in skilled trades, defects were present in 29.0 per cent at ages 20-24 and increased to about 75 per cent at ages 55 and over.

Field Opinions

A *motor car* manufacturer reports that with improved lighting in sanding booths workmen can see finger marks more easily and correct them quickly.

A builder of *metering instruments* is convinced that better lighting aids production by making it easier to see the marks when working on polished surfaces.

A *lamp manufacturer* reports that the time for training new women operators is greatly reduced by improved lighting. He found a definite relation between rate at which each new operator comes up to maximum production and the increase in general lighting.

A manufacturer of *small machine parts* who does a great deal of precision work finds his men can read scales and blueprints easier at night than by daylight.

A manufacturer of *steel sash equipment* reports it is much easier to read blueprints with improved lighting.

In a *factory office* it is reported th better lighting improved color quali reduced shadows and made it easier see pencil lines on prints.

In a large *factory office* the old ligh ing was inadequate for the staff to ke up with its increased work due to w time pressure. Now, with new lighti (25 footcandles) it can perform t necessary work without undue effort.

An *electrical equipment* manufactur reports that the previously difficult co matching of coded wires is now easy u der new lighting.

The *timekeeper* of a large shop f merly had difficulty sorting yellow-gre and blue cards. The lighting was i creased (to 45 footcandles). Now has no trouble.

LESS EYESTRAIN AND FATIGUE

Laboratory Findings

Researches reveal that muscular f tigue produced by reading is appro mately three times as great after readi for an hour under one footcandle a is after an hour's reading of the sa printed matter under 100 footcandles.

Field Opinions

A manufacturer of *metering inst ments* reports a decided decrease in e strain and that working conditions more efficient in his engineering of where lighting has been increased (footcandles).

A *small machine parts* manufactu states that since relighting, men g weight on the night shift.

The sales manager of a company s cializing in *steel spinnings* reported t after new lighting was installed (ra ing from 30 to 110 footcandles) employees were more "peppy" at end of a 10-hour day than they forme were at the end of an 8-hour day.

A manufacturer of *intricate alumin castings* reported that his workers w less tired at the end of the day w new lighting (35 to over 60 footcand with higher values at final inspect benches). Similar reports of reduct in "tiredness" at the end of the day w made by various manufacturers, incl ing *motor trucks, automatic mach tools, textiles, airplanes,* and *printing*

"Less headaches" after better light was installed were credibly reported manufacturers of *airplane parts* (asp tablet consumption decreased from 1 to 600 tablets per month) *autom machinery, castings, textiles, engi chemicals, cooling systems, paints, trical equipment,* etc.

BETTER UTILIZATION OF FLOOR SPACE

Field Opinions

In one plant a study after new lighting was installed resulted in the rearrangement of a large buffing and polishing department, thereby making 8,000 square feet of floor space available for other uses.

A manufacturer of *electrical equipment* reports better utilization of floor space after relighting—a 25 per cent reduction in floor space for a given amount of work.

An *electrical parts* manufacturing company reports that improved lighting permits better arrangement of machines and more efficient use of floor space.

The management of a *general machine shop* finds that with 40 footcandles general lighting, and supplementary lighting up to 75 footcandles where necessary, machinery and equipment can be arranged without regard to light sources, i.e., maximum utilization of floor space. A similar report was made by a *hardware manufacturing* company.

A *heavy machine tool* builder states that with better lighting the ability to see all around the machine is very valuable.

EASIER TO KEEP PLANT CLEAN

Field Opinions

A *roller bearing* manufacturer finds that with new lighting (45 footcandles) dirt and clutter are more evident and therefore more quickly removed.

An *automatic machine tool* manufacturer reports great improvement in housekeeping with increase in illumination from 8-10 footcandles to 30 footcandles.

A *lamp* manufacturer and a *hardware* manufacturer found a general improvement in plant cleanliness when better lighting was installed.

IMPROVED LABOR CONDITIONS

Field Opinions

A manufacturer of *airplane parts* reports that after better plant lighting was installed, morale improved, and there were fewer yard fights. *Office* morale revived when illumination was increased from 8 to 60 footcandles.

An *ordnance plant* reports great satisfaction of new labor when lighting was improved. "It made them want to work here."

A manufacturer of *machine tools* reports that they were compelled to put new lighting (35-50 footcandles) to obtain mechanics.

A *roller bearing* manufacturer reports that on three-shift operation the difference between relighted and older sections is particulary noticeable to the operators. Operators in older sections not relighted are particularly vocal in request for relighting.

Statements that there is general improvement in workers' morale when better lighting is installed were made by manufacturers of *hardware, textiles, lamps, electrical* and *ship parts,* and a shop for *casting and machining heavy airplane parts.*

A manufacturer of *steel spinnings* reports that with good lighting inside, employees are satisfied in spite of the blackout (closing of windows, etc.).

A manufacturer of *small machine parts* says that nearly all employees preferred to work at night after new lighting was installed. A similar statement was made by a manufacturer of *electrical machinery.*

GREATER SAFETY

Laboratory Findings

For some types of work it is essential to see large objects which have a low brightness contrast with their background. For instance, many accidents are caused by operators stumbling on or walking into large objects which are hardly distinguishable from their background. As lighting is increased from 1 to 100 footcandles "contrast sensitivity" or ability to distinguish differences in brightnesses is increased several fold. With better lighting the hazards are more clearly revealed, and workers see more quickly and with greater certainty.

Field Opinions

An *ordnance plant* with improved general lighting (30 footcandles) and some supplementary lighting reports increased safety, particularly in breaking in green labor.

A *ship-building* plant and a manufacturer of *steel sash equipment* both report that new lighting considerably reduced the blinding effect of flashes from welding torches.

General statements that good lighting is responsible for increased safety and fewer accidents were made by a number of manufacturers, including a *machine shop,* a *rebuilder of machine tools,* a *hardware* manufacturer (especially in automatic screw machine department), and an *airplane parts* manufacturer.

A *textile* manufacturer with a new lighting system reports that it has decreased fire hazards.

POOR SEEING CONDITIONS ARE WIDESPREAD

The visits to war-production plants also revealed widespread opportunities for improving seeing conditions by means of artificial light, and other controllable aids to seeing. Many industrial plants have scarcely emerged from the era of "mere light and barely seeing." Glaring light-sources, dingy interiors, poorly-distributed light and improperly-directed light are too prevalent to result in the maximum production from those facilities.

By no means were all opinions and conclusions of executives as clear cut, as positive, or as enthusiastic as the comments presented on previous pages. However, there was plenty of evidence that many executives knew little about artificial lighting and gave little or no attention to it. Indifference toward lighting was too common, as was obvious from some of the interviews with executives and from casual observation of the lighting and seeing conditions.

APPENDIX A

Elements of Good Lighting

For a more comprehensive treatment of all phases of artificial lighting for factories, including a table of minimum lighting values, see "American Recommended Practice of Industrial Lighting." Approved March 17, 1942, by American Standards Association. Copies of these standards may be obtained from the Illuminating Engineering Society under whose sponsorship the standards were prepared.

An adequate amount of light simply means plenty of light of the proper quality for the specific tasks of seeing. Seeing tasks can be graded approximately according to their difficulty, and an appropriate level of illumination in footcandles can be recommended for the various grades.

The purpose of grading the seeing tasks and of supplying different levels of illumination for the different grades is to make the ease or difficulty, of seeing, approximately the same for the various tasks.

The following tabulation is presented to give a general idea as to the types of seeing tasks falling within the various grades:

Group A

These seeing tasks involve (a) the discrimination of extremely fine detail under conditions of (b) extremely poor

(*Continued on page* 61)

Twenty-four Edison Electric Institute Awards for Resuscitation Made in 1942

By Mae B. Woods

Secretary, Committee of Judges for the Awards

SO MANY Edison Electric Institute Medals for resuscitation were awarded during the past year that it is necessary, for lack of space, to depart from our usual custom of reporting all of them in the February issue. Another installment will appear in the March number of the BULLETIN. Twenty-four awards, including the large Medal and miniatures, a record breaking number for a twelve month period, were presented to a total number of sixty-five employees, including members of line crews and individuals, of light and power companies. Awards were made for both prone pressure and pole top resuscitation.

The number of officially certified resuscitations in the electric light and power industry is now 565. One hundred and fifty one of these have been commemorated by Edison Medals; in 414 previous cases the employees who effected resuscitation received the Insull Medal of the National Electric Light Association.

Employees of all electric light and power companies eligible for the Edison Medal. A certificate describing act of resuscitation, signed by the President of the Insti is presented with each medal and a Certificate of Assist is awarded those who have rendered valuable aid in res tation. Miniature medals and certificates are also give members of line crews who have participated in case successful resuscitation.

The sentimental and historical value of the medal enhanced by the inclusion of copper from the original t wire system laid down in New York City in 1881 by late Thomas A. Edison as part of the world's first un ground system for the distribution of current for elec light and power.

A partial list of recipients of the Medals awarded 1942 and brief statements of the circumstances leading their award follow:

ROBERT A. CRUZEN
Oregon

Jack M. Friend, lineman, Pacific Power and Light Company, was working on a pole supported transformer platform on August 17, 1939, changing position of the conductors of a 7200-volt, 3-phase delta circuit. In some manner he made contact with one of the 7200-volt conductors at a point just above his glove on the left arm. Ground contact was made through his right leg to a bolt of the structure. Friend fell clear and was held suspended by his safety belt.

The accident was observed by Robert A. Cruzen, foreman, who was standing on the ground at the foot of the pole. He immediately climbed the pole and gave artificial respiration by the Pole Top Method as Friend was held in a clear position by Myrl Walsh, lineman. After about ten minutes of resuscitation Friend showed signs of recovery and after another 10 minutes was breathing without assistance. Doctors from nearby responded and Friend was later taken to a hospital by ambulance.

The Edison Medal and Certificate were presented to Mr. Cruzen on February 17th, 1942, by Mr. George T. Bragg, Vice-President and General Manager, and Mr. R. H. Skill, District Manager, at Pasco, Oregon, before a gathering of members of the Pasco Division of the Pacific Power and Light Company.

WILFRED T. BARNES
Rhode Island

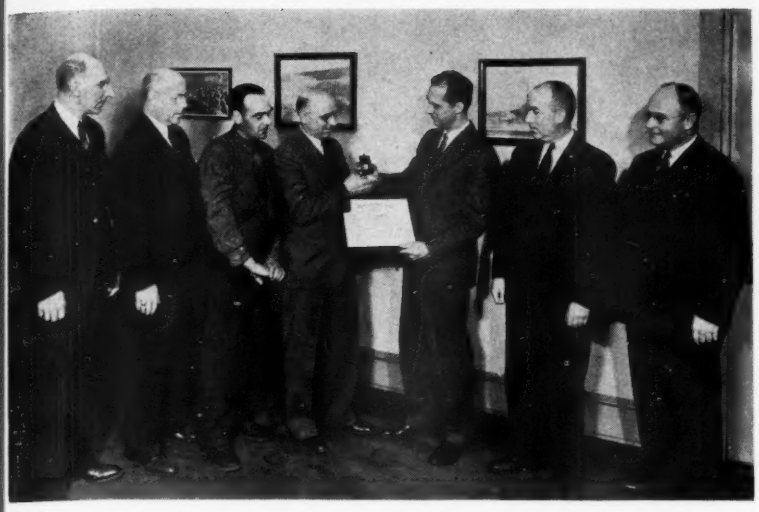
On April 1, 1941, at 9:45 a.m. while working in a construction crew of the Narragansett Electric Company under the supervision of electrician foreman Wilfred T. Barnes, Joseph M. Sheridan, electrician, received an electric shock, from a three-phase primary distribution circuit of a voltage of 2300 volts to ground, which rendered him unconscious. Work was to be done in an industrial substation installed to supply power to concessions in an amusement park at Rocky Point and Sheridan was examining conditions determine how to proceed with the w when he slipped from a ladder and lost balance. In attempting to save himself f falling he placed his left hand on a c arm supporting primary connections to lighting transformer. Contact was made Sheridan to the 4000-volt lead with his hand and to ground through his feet w touched the enclosing chain link fence.

Mr. Barnes, the foreman, started gi artificial respiration by the prone pres method and in approximately eight min Sheridan showed signs of recovery and about ten minutes was breathing unassis Clarence E. Anderson relieved Barnes so the latter could treat the burns of the inj and render other first aid. Frank Phil summoned a physician and when he arri about twenty minutes after the accid Sheridan was found in good condition. S idan was taken by the doctor to his office medical treatment and then to the hosp

Mr. Samuel C. Moore, President of

ROBERT A. CRUZEN, Pacific Power & Light Co., Center. George T. Bragg, Vice-Pres., on the left, and R. H. Skill, Pasco Division, Manager, to the right.

WILFRED T. BARNES, Narragansett Electric Company, receives Edison Medal from Samuel C. Moore, President of the Company.



C. H. KLOTZ, Pennsylvania Power & Light Co., Center. Left to right: P. L. G. Hasskarl, Safety Engineer; W. M. Seiple, Division Superintendent; L. M. Cora, First Class Lineman; Mr. Klotz, Safety Instructor; F. C. Mueller, Division Manager; S. R. Gearhart, Assistant Division Superintendent, and H. K. Lear, District Manager.

Narragansett Electric Company, presented the Edison Medal and Certificate to Mr. Barnes at the Company's Annual No-Accident Safety Campaign, Sept. 29, 1942, in the presence of approximately one hundred and fifty fellow employees, all of whom were of the Supervisory group. The presentation took place in the Company Auditorium.

CONRAD H. KLOTZ
Pennsylvania

On July 28, 1941, Joseph Garafalo, an employee of the Scranton Contracting Company, was working underneath an electric shovel, blocking levers that hold the bucket in position. In so doing he handled the cable which supplied power to the shovel at 4,000-volts, three phase. Garafalo received a shock at 2300-volts, the system ground voltage, as a result of defective insulation of the cable, it was later found. J. E. Harrington, superintendent and owner of the Scranton Contracting Company, shut off the power and de-energized the cable. Conrad H. Klotz, Safety Instructor of the Pennsylvania Power and Light Company, was just leaving the company office when he was informed by W. M. Seiple, Division Supt., that a man was caught on 2300-volts at the plant of the Dick Construction Company. Klotz drove to the location, which was about a mile and a half away. Garafalo was lying face down under the electric shovel and in a pool of water. Klotz started artificial respiration at once and after about one minute Garafalo responded and breathed faintly and slowly. With the assistance of persons nearby Klotz moved Garafalo to administer first aid. A doctor had been called but before he arrived Klotz placed Garafalo on a stretcher and made him ready for transportation. Supt. Seiple had dispatched M. E. Hildebrand and Louis M. Cora to assist Klotz and as soon as they arrived Garafalo was placed in the P. P. & L. Company service truck and taken to the hospital. En route Garafalo's breathing stopped again and Klotz continued artificial respiration for about ten minutes longer at which time Garafalo moved and groaned. At the hospital the doctor who took charge stated that pulse was fairly good, the patient being still unconscious but breathing.

Presentation of the Medal and Certificate to Mr. Klotz was made at Wilkes-Barre, Pa., by Mr. F. C. Mueller, Division Manager, on April 16, 1942, at a gathering in his office of company employees.

SAMUEL KAPOI
Hawaii

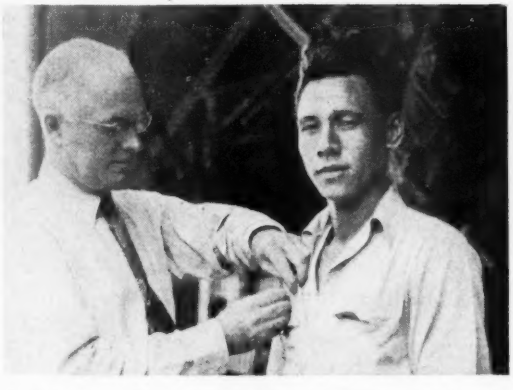
A gang of maintenance men of the Hawaiian Electric Company, Ltd., under the foremanship of Joe Apana, was working at a Substation on April 30, 1941, scraping, chipping and plaiting the steel structure. The upper section of the structure was out of service and after ladders were rigged, paint mixed, etc., the electrical circuits and switches were again checked and found in order for clearing the upper section.

Samuel Kapoi, first class journeyman lineman, and William Pa, first class apprentice lineman, were working on the structure. Kapoi went up to the top section and saw Pa on the ground. For some reason unknown to Foreman Apana, Pa had climbed up on the structure again and was leaning over apparently reaching for a hand line when Apana saw him. Apana feared to call lest he startle Pa and just then there was an explosion of an arc. Afterward it appeared that Pa's foot had slipped off the steel cross member and touched a live 11,000-volt tap. He cleared himself momentarily but lost his balance and struck the line fuse holder with the same foot.

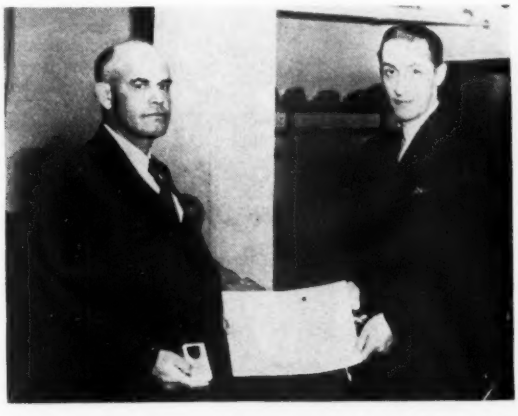
Kapoi was busy painting when he heard the loud noise from the arc and looking around saw Pa lying across the corner of the structure apparently stiffened. Kapoi slid down the upright and ran to the circuit breaker box to trip the circuit. At this point Pa fell to the ground and Kapoi immediately ran to him, straightened him out, turned him over, and started artificial respiration by the prone pressure method. After about four minutes Pa showed signs of revival but was breathing hard. Apana relieved Kapoi in giving artificial respiration after opening the circuit breaker and requesting a neighbor to call for the ambulance. In about seven minutes Pa was breathing without assistance and was semi-conscious when taken by ambulance to the hospital.

On June 28th, 1942, a Laua (Hawaiian Feast) was given to 350 members of the various departments of the Hawaiian Electric Company as a reward for the splendid records made during the year 1941. The guest speaker was Lt. Colonel Foster of the U. S. Engineers who gave a talk on the connection between the Company and the U. S. Army in erection of defenses for the Island of Oahu.

Mr. L. A. Hicks, General Manager, presented Samuel Kapoi with the Edison Medal and Certificate. In his presentation Mr. Hicks noted that Kapoi's rapid thinking and quick and efficient action in saving the life



SAM KAPOI, The Hawaiian Electric Company, right, receives Edison Medal from L. A. Hicks, General Manager of the Company.



MARALBA D. KERSHAW, Utah Power & Light Co., right, receives Edison Medal from Earl A. Hewitt, Safety Director of the Company.

of Pa was the result of many weeks of practice in resuscitation.

MARALBA D. KERSHAW
Utah

An 11,000-kva line was being installed on poles carrying a 44,000-volt 3-phase circuit on the system of the Utah Power and Light Company by a line crew under Foreman Fred W. Spillman. On August 7, 1941, slack was being pulled up and Foreman Spillman was on a dead end pole setting dead end clamps. Lineman Maralba D. Kershaw, Orson James, Morgan Evans and Clifford Cole were on the ground pulling slack hand tight when the conductor being pulled up caught under a sage brush. As it cleared it flipped up and struck one phase of the 44,000-volt line above. All five men were stunned by the shock. Evans and Kershaw recovered about the same time and seeing James and Cole lying unconscious on the wire took a rope between them and flipped them free.

Kershaw immediately started artificial respiration on James, and Evans started working on Cole. As soon as Spillman came to he descended the pole and relieved Evans who ran a quarter of a mile to the truck and then drove six miles to phone for a doctor. The hot wires started a fire in the dry grass and sage brush and the wind was blowing it toward the men. Kershaw carried James about 200 feet down hill continuing respiration by the pole top principle enroute. After about thirty minutes, James was revived. Spillman was not able to handle Cole in the same manner and was having difficulty keeping him clear of the fire. Kershaw propped James up against some brush and brought Cole down the hill as he had James. Spillman continued artificial respiration for Cole as Kershaw held his head and talked to James to keep him conscious. When the doctor arrived he pronounced Cole dead. James was taken to the hospital for treatment and Kershaw and the other members of the crew went in for a check up.

Safety Director, Earl A. Hewitt, of the Utah Power and Light Company, presented the Edison Medal and Certificate to Mr. Kershaw before the employees of the Preston, Utah, Division, on April 20, 1942.

D. M. MANES
Oklahoma

On October 20, 1941, D. M. Manes, groundman, employed by the Oklahoma Gas and Electric Company, was sent to help lineman Roy Vick change size of fuse links in 2 sets of S. & C. repeating fuse mountings. These fuses were to be changed from 75 amp to 50 amp due to this system having been recently cut-over from delta to wye, 2.4 Kv to 4.16 Kv. Vick climbed the pole and put a jumper across the east set of fuses on the north side of the pole and then swung around to the south side of the pole to take out the fuse cartridges and replace the fuse links. At this time he was east of the primary neutral which was carried on a neutral bracket below the braces of the lower arm. Manes was picking up fuse links when he heard an arc and saw that Vick had come in contact with the hot parts of the unit on the east phase and the primary neutral. Manes ran to the pole and jerked the handline which Vick had attached to his belt. This freed him from the contact, and he slowly fell down the pole in a series of jerks. When Vick hit the ground his clothes were burning on the right sleeve and left thigh. Manes put out the fire with his hands, and immediately started artificial respiration. In about three minutes Vick showed signs of life and in four minutes he breathed without assistance. A truck driver was dispatched to telephone for an ambulance and call the O. G. & E. office. The injured was taken to the hospital.

The presentation ceremony took place in Fort Smith, Arkansas, on April 14th, 1942, at the spring meeting of the Men's Club of the company's Arkansas Division, at wh 200 members of the company were pres Mr. F. J. Meyer, Vice-President, presen the Medal and Certificate to Mr. Manes

DOUGLAS M. MANES
Oklahoma Gas and Electric Co.

BERT BARFUS, Idaho Power Co., receives Edison Medal from D. S. Brown, Pocatello Division Manager.

BERT BARFUS
Idaho

On October 17, 1941, Bert Barfus, linem and William E. Davis, apprentice linem of the Idaho Power Company, Pocat Idaho, were changing taps on pole mou distribution transformers because of a r in substation voltage from a 2300-volt b to a 2400-volt base. After apprentice l man Davis had completed the tap cha and closed the cutout on a particular un was noted by lineman Barfus that there no connection from the neutral lead w along the transformer case in accord with standard practice for the primary's terconnected neutral system. Barfus structed Davis to make this connection using a wire than appeared to be an a tional and unnecessary tie between the mary neutral of the transformer near bushing and the lightning arrestor gro wire. Subsequent investigation showed conditions to be such that this wire was primary neutral connection for the tr former and when Davis opened the con tion he inadvertently placed himself in se with the circuit from the 2400-volt prim through the transformer to himself to gro

HARRISON D. ETTINGER LINE CREW, Philadelphia Electric Co. Left to right: Ra Efferson; LeRoy J. Gottshall; H. B. Bryans, Vice President and General Manager Mr. Ettinger and Terrance T. Taffe.

was rendered unconscious and turned in his belt, hanging head down. Barfus standing on the ground near the pole. immediately climbed and in less than 2 utes was administering artificial respira- by the pole top method. Earl R. Gilbert, ision Service Foreman, whose home was by, had been talking with Barfus and to his car for his spurs and belt. When returned he assisted Barfus in lowering vis and in taking him to the Pocatello eral Hospital nearby.

Mr. Barfus was presented with the Edison dal and Certificate at a gathering of em- ees and friends in the Company Audi- um on March 31st, 1942. Mr. D. C. wn, Manager of the Pocatello Division he Company, made the presentation.

HARRISON S. ETTINGER'S LINE CREW

Pennsylvania

A Line Crew of the Philadelphia Electric mpany, Philadelphia, Pa., under Foreman rison Ettinger, was setting poles on No- ber 5, 1941, near Rushland Substation in Eastern Division. While in the act of embling the boom on the truck, the boom e in contact with a 2300-volt line and rgized the truck. Unaware of this situa- , Paul J. Beerbower got down from the r of the truck, still grasping the lifting e, and when his feet touched the ground was frozen to the wire and, therefore, d not let go. Harrison S. Ettinger imme- ely placed Beerbower in the prone posi- and proceeded to administer the prone ssure method of resuscitation, which was inued for a period of about two minutes n Beerbower showed signs of returning to sciousness. In order to make sure that the im would not lapse into a state where would be necessary to revive him again, oy J. Gottshall relieved Mr. Ettinger and inued to apply prone pressure for a short iod of time while Mr. Ettinger attended other matters concerning the job which being performed at the time of the dent. Ray Efferson and Terrance T. fe assisted by rubbing the victim's arms legs. As soon as it was felt safe to sport the victim, he was taken to the lestown Hospital.

Mr. H. H. Bryans, Vice-President of the ladelphia Electric Company, presented Medals and Certificates to Mr. Ettinger members of his Line Crew on March 1942.

HARRY G. BLOOD, Fitchburg Gas & Electric Light Co., Center. Left to right: Major John T. Burke, U. S. Army; Chief Quartermaster John H. Burke, U. S. Navy; Mr. Blood, and A. G. Neal, Manager of the Fitchburg Gas & Electric Light Co.

LESLIE G. SMITH

Pennsylvania

On the morning of June 14, 1940, part of a line crew under the supervision of First Class Lineman Paul Hatfield of the Pennsylvania Power and Light Company, Allentown, Pa., was engaged in reinsulating and otherwise preparing a 2300-volt circuit for changeover to 6900-volt operation. While placing rubber protective equipment on a phase wire, lineman Howard Hatfield, in some manner, made contact with a 2300-volt jumper at his left ear and left arm. He was rendered unconscious.

Lineman Elmer Haines immediately cut jumper freeing Hatfield from current and First Class Lineman Leslie Smith took several steps up pole and after getting Howard Hatfield in position applied pole top resuscitation for two or three minutes when he started to breathe and regain consciousness. While Smith was applying the pole top resuscitation Haines was getting rope in position to lower him to the ground. Hatfield was conscious when he reached ground and was immediately placed on blanket and covered and treated for shock until ambulance arrived. He was taken to the Williamsport Hospital.

The Medal and Certificate were presented to Mr. Smith by Mr. E. E. Mensch, Manager of the Williamsport Division of the Pennsylvania Power and Light Company, on May 20, 1942, at a gathering of company employees.

HARRY GRAHAM BLOOD

Massachusetts

On May 16, 1941, a line crew of the Fitchburg Gas and Electric Light Company under Foreman Bernard Basque was making alterations to the lighting of a band stand in the Common, Townsend, Mass. Lineman Donald Chalmers climbed a thirty-five-foot pole for the purpose of making a tap to a street light circuit loop. Circumstances indicated that just as he was about to snap his belt catch into the D ring, his foot slipped from a secondary cross arm on which he was standing and he fell into a three-phase, 2300-volt commercial lighting circuit. Lineman Harry Graham Blood, who was on a ladder installing a lighting fixture at the band stand, heard Chalmers' scream and saw him trying to pull himself clear of the wires. Blood ran to the truck, quickly put on his belt and climbers and, putting on his gloves as he ran, climbed the adjacent pole to cut the wires on which Chalmers was caught. Hurrying back he took the left belt which Basque had made ready and climbed up to where Chalmers was lying unconscious across the now deenergized wires. Fastening the rope which he had placed over a cross arm to Chalmers' body belt he guided Chalmers' body through the wires as it was lowered by Basque. Blood started the prone pressure method of resuscitation as soon as Chalmers was placed in position and continued until relieved by foreman Basque at the suggestion of the doctor who had arrived. Assistance was given in handling Chalmers by Wm. T. MacMasters, Chairman of the Board of Park Commissioners of Townsend. Chalmers was taken to the Burbank Hospital in Fitchburg.

At the annual meeting of the Fitchburg Gas and Electric Club and Mutual Benefit Association on April 29th, 1942, Mr. Blood was presented the Medal and Certificate by Mr. A. G. Neal, Manager of the Company.

LESLIE G. SMITH, Pennsylvania Power & Light Co. Left to right: H. M. Brown; Mr. Smith; A. B. Kilgo; E. E. Mensch; E. E. Chubbuck; G. E. Wheeler; P. L. G. Hasskarl and D. J. Zimmerman.

EMPORIUM LINE CREW, West Penn Power Co. Left to right: Harry B. Park; Lester M. Anderson; Harry Spangler; Donald J. Minard; James L. LaBorde; Ralph C. Possinger; Rennie Shilk; H. F. Webb, Gen. Safety Director, and J. E. Fife, Supt.

Among the guest speakers were Major John T. Burke and Chief Quartermaster John H. Burke. This meeting was attended by more than one hundred fifty employees and friends.

EMPORIUM LINE CREW

Pennsylvania

The Emporium Line Crew of the West Penn Power Company, Pittsburgh, Pa., was engaged in changing a 4000-volt circuit from an old 45-foot chestnut pole to a 50-foot cedar pole on October 7, 1941, at Emporium, Pa. In accordance with instructions of Foreman H. B. Park, lineman Rennie Shilk climbed the old pole to help transfer the neutral wire to the new pole. The phase wire had been transferred. A permanent jumper for connection between main line and branch live wires was disconnected from the primary but Shilk came to the latter with the other end bare for two inches for use with a solderless connector.

Shilk assumed his position on the pole with approximately twenty-eight inches horizontal clearance from the jumper. Probably as the result of a cut out from the old pole, he made contact with the bare end of the jumper at the left side of his neck while his right foot was in contact with a telephone messenger. Lineman Harry Spangler was working above Shilk. He quickly let himself down and pulled the jumper way. Lester Anderson and Donald J. Minard, linemen, assisted Spangler in attaching a hand line to Shilk. With the assistance of Ralph C. Possinger and James L. LaBorde, other members of the crew, Shilk was quickly lowered to the ground, and Anderson immediately started prone pressure method of resuscitation. Anderson was relieved by Spangler in giving artificial respiration. Foreman Parks summoned the doctor and ambulance and rendered general assistance to the resuscitation effort.

The presentation of the Medals and Certificates to the Emporium Line Crew took place at a dinner meeting held at Emporium, Pa., on May 12, 1942. The presentation was made by Mr. H. F. Webb, General Safety Director of the Company.

NELSONVILLE LINE CREW

Ohio

On October 7, 1941, lineman Charles Anderson, a member of the Nelsonville Line Crew, Southern Division of the Columbus and Southern Ohio Electric Company, was climbing a fifty-foot creosoted pole, which was part of a dead end "H" structure with five lines carrying 13,200 volts each with three diverging lines connected by jumpers. For some reason he was on the wrong side of the pole and his body struck the 13,200-volt jumper leading away from the pole. Foreman Walter Sanner, and linemen Earl Morris and Everett Carroll, other members of the crew, were all at the bottom of the pole. Morris was preparing to ascend the pole and was looking at Anderson as soon as contact was made he climbed where Anderson lay on a group of phone wires twenty-five to thirty-feet above the ground. Quickly placing the hand which Anderson had carried up with over a lower cross arm, he secured Anderson's belt and requested Sanner Carroll to lower Anderson as soon as was dislodged from the wires.

When Anderson's body reached ground it was quickly placed in position and Sanner started resuscitation, Carroll sisting. As soon as Anderson regained consciousness he was made comfortable Sanner went to Nelsonville for a doctor and ambulance.

The Nelsonville Line Crew was honored at a dinner in Nelsonville, Ohio, on April 17, 1942, at which time the Edison Medals and Certificates were presented.

NELSONVILLE LINE CREW, Columbus and Southern Ohio Electric Co. Left to right: Earl E. Grover, Director of Safety; Foreman Walter Sanner; Earl J. Morris, and Everett E. Carroll.

Allocating Gross Revenue to Production, Transmission and Distribution Facilities

By Norman F. Brown

Engineer Accountant, Southern California Edison Company Ltd.

OPERATORS and managers of electric utilities have always had detailed reports on costs of operating the various generating stations, transmission lines, and distribution equipment in their systems. They also have had detailed reports on revenues by geographical areas and customer groups, but if they have ever wanted to know how much revenue was contributed by each generating station or transmission line in order to determine net earnings from individual power units or primary power costs, they have faced a perplexing problem.

In a system which has only one generating station and one transmission line the allocation of gross revenue between production, transmission, and distribution sections is somewhat difficult, but not extremely so. In a system which has many steam and hydro generating units all interconnected with transmission lines, the problem is very complicated.

Elaborate installations of indicating and recording instruments could furnish the necessary basic data, but a far less costly solution can be made by a practical application of some of the mathematical tools used by engineers and statisticians. A process for allocating gross revenue to individual sections of an electric utility by using the mathematics of multiple correlation is described below. The demonstrated process is largely confined to producing the net earnings for one hydro generating station within a group of hydro stations, but the process can be applied to other parts of the electric system.

This process assumes first that there are several major subdivisions in an electrical utility such as:

1. Hydro Production
2. Steam Production
3. Transmission
4. Distribution and Commercial
5. General and Administrative

It is further assumed that the two main elements which contribute to operating revenue are:

a. Investment

b. Operating expenses including Taxes and Depreciation

Operating revenue is realized only as the result of effort. The combination of physical plant and facilities and organized manpower devoted to the single purpose of operation for production of dollars constitutes the effort. The investment in plant and facilities is the measure of effort exerted by physical properties and the amount of operating expenses indicates the amount of effort exerted by the operating forces. These basic statements presuppose the assumption that before the physical properties were constructed, engineering surveys and studies had satisfactorily demonstrated the economic feasibility of the electric system. Obviously it cannot be assumed that high investment and high operating expenses automatically produce high operating revenues. There are, of course, many other elements which affect operating revenue. These are of a daily, weekly, seasonal or economic nature, but it is assumed that the elements named above are of greatest importance. These elements exist in measurable quantities in all subdivisions. The other elements affecting operating revenues are either considered to have a uniform effect on both investment and expenses, or are allowed to express themselves as constants in the mathematical formulae that are subsequently derived. Table 1 shows experience in these three elements during the years 1920 to 1941 inclusive.

TABLE 1

Year	Operating Expenses	Investment	Operating Revenue
1920	$2.51	$20.3	$ 3.62
1921	2.65	20.6	4.10
1922	2.62	30.2	4.21
1923	2.70	31.4	5.42
1924	2.71	35.0	5.75
1925	3.02	53.2	6.81
1926	3.34	59.7	7.48
1927	3.35	60.2	8.15
1928	4.01	77.5	9.38
1929	4.32	78.6	10.45
1930	4.03	80.7	10.85
1931	4.52	90.2	10.15
1932	3.51	90.8	9.80
1933	3.70	100.3	9.15
1934	3.98	100.5	9.72
1935	4.03	100.9	10.25
1936	4.06	103.7	10.75
1937	4.52	104.8	10.68
1938	5.03	105.7	10.91
1939	5.25	108.2	12.25
1940	6.04	109.5	13.01
1941	6.73	110.5	13.20

Following the basic assumption that revenue is a function of both expenses and investment, the next step is to express the mathematical relationship between the independent variables of expenses and investment, and the dependent variable of revenue. This is done by the formula:

$R = a + bS + cT$, in which
R = Operating Revenue
S = Operating Expenses
T = Investment, and

a, b, and c are mathematical constants whose values can be easily determined by solving the following simultaneous equations, which are determined by the "least squares" method:

(1) $\Sigma(s^2)b + \Sigma(st)c = \Sigma(sr)$
(2) $\Sigma(st)b + \Sigma(t^2)c = \Sigma(tr)$

These terms, s^2, st, sr, etc., are derived by the group of formulae below and the data in Table 2.

(3) $M_r - bM_s - cM_t = a$

M_r, M_s, and M_t are the mean values of Revenue, Expenses, and Investment shown in Table 2.

$\Sigma(s)^2 = \Sigma(S)^2 - n(M_s)^2$

From Table 2, $\Sigma(S^2) = 367.12$, n = the number of years or 22, and (M_s) = the mean value of Expenses or 3.94

$= 367.12 - (22 \times 3.94 \times 3.94) = 25.68$

$\Sigma(st) = \Sigma(ST) - n(M_sM_t)$
$= 7{,}202.38 - (22 \times 3.94 \times 76.01)$
$= 613.82$

$\Sigma(t)^2 = \Sigma(T)^2 - n(M_t)^2$
$= 148{,}167 - (22 \times 76.01 \times 76.01)$
$= 21{,}062$

$\Sigma(sr) = \Sigma(SR) - n(M_sM_r)$
$= 833.81 - (22 \times 3.94 \times 8.92)$
$= 60.73$

$\Sigma(tr) = \Sigma(TR) - n(M_tM_r)$
$= 16{,}727.60 - (22 \times 76.01 \times 8.92)$
$= 1{,}811.38$

Substituting, the values of Σs^2, Σst, etc., derived above, in formulas (1) and (2):

$25.68b + 613.82c = 60.73$
$613.82b + 21{,}062.00c = 1{,}811.38$

Solving these simultaneous equations, $b = 1.019$, $c = 0.0563$

Using these data, the mean values of R, S, and T in Table 2 and Formula 3:

$8.92 - (1.019 \times 3.94) - (0.0563 \times 76.01) = a$
$0.63 = a$

The complete equation can now be stated as:

$$R = 0.63 + 1.019S + 0.0563T$$

The mathematical test of this formula in Table 3 demonstrates that the "least squares" process expresses the relationship between expenses, investment and revenue very closely in total, but deviations in the year-to-year data are fairly large. This is because the formula does not recognize the complex curvilinear relationships in the year-to-year data. Adjustments must be made to the linear equation to make it re more nearly the true relationship the three variables.

This is done by the semigraphic p ess in which revenue is first expresse a function of expenses while investm is held constant at its average value,

TABLE 2

Year	Expenses S	Investment T	Revenue R	S^2	ST	SR	T^2	TR
1920	2.51	20.3	3.62	6.30	50.95	9.09	412	73.49
1921	2.63	20.6	4.10	6.92	54.18	10.78	424	84.46
1922	2.62	30.2	4.21	6.86	79.12	11.03	912	127.14
1923	2.70	31.4	5.42	7.29	84.78	14.63	986	170.19
1924	2.71	35.0	5.73	7.34	94.85	15.53	1,225	200.55
1925	3.02	53.2	6.81	9.12	160.66	20.57	2,830	362.22
1926	3.34	59.7	7.48	11.16	199.40	24.98	3,564	446.56
1927	3.33	60.2	8.15	11.09	200.47	27.14	3,624	490.63
1928	4.01	77.5	9.38	16.08	310.78	37.61	6,006	726.95
1929	4.32	78.6	10.45	18.66	339.55	45.14	6,178	821.57
1930	4.03	80.7	10.85	16.24	325.22	43.73	6,512	875.60
1931	4.52	90.2	10.15	20.43	407.70	45.98	8,136	915.53
1932	3.51	90.8	9.80	12.32	318.71	34.40	8,245	889.94
1933	3.70	100.3	9.15	13.69	371.11	33.86	10,060	917.75
1934	3.98	100.5	9.72	15.84	399.99	38.69	10,100	976.86
1935	4.03	100.9	10.25	16.24	406.63	41.31	10,181	1,034.23
1936	4.06	103.7	10.75	16.48	421.02	43.65	10,754	1,114.78
1937	4.52	104.8	10.98	20.43	473.70	49.18	10,983	1,140.22
1938	5.03	105.7	10.91	25.30	531.67	54.88	11,172	1,153.19
1939	5.25	108.2	12.25	27.56	568.05	64.31	11,707	1,325.45
1940	5.04	109.3	13.01	36.48	660.17	78.58	11,946	1,421.99
1941	5.73	110.5	13.20	45.29	743.67	88.84	12,210	1,458.60
Totals	86.59	1,672.30	196.27	367.12	7,202.38	833.81	148,167	16,727.60
Means	3.94	76.01	8.92	ΣS^2	ΣST	ΣSR	ΣT^2	ΣTR

These Totals Are:

TABLE 3

Year	(1) Expenses S	(2) Investment T	(3) Expenses x 1.019	(4) Investment x 0.0563	(5) Constant	(6) 34445 Estimated Revenue	(7) Actual Revenue	(8) Deviation
1920	2.51	20.3	2.56	1.14	8.63	4.33	3.62	-0.71
1921	2.63	20.6	2.68	1.16	.63	4.47	4.10	-0.37
1922	2.62	30.2	2.67	1.70	.63	5.00	4.21	-0.79
1923	2.70	31.4	2.75	1.77	.63	5.15	5.42	+0.27
1924	2.71	35.0	2.76	1.97	.63	5.36	5.73	+0.37
1925	3.02	53.2	3.08	3.00	.63	6.71	6.81	+0.10
1926	3.34	59.7	3.40	3.36	.63	7.39	7.48	+0.09
1927	3.33	60.2	3.39	3.39	.63	7.41	8.15	+0.74
1928	4.01	77.5	4.09	4.36	.63	9.08	9.38	+0.30
1929	4.32	78.6	4.40	4.43	.63	9.46	10.45	+0.99
1930	4.03	80.7	4.11	4.54	.63	9.28	10.85	+1.57
1931	4.52	90.2	4.61	5.08	.63	10.32	10.15	-0.17
1932	3.51	90.8	3.58	5.11	.63	9.32	9.80	+0.48
1933	3.70	100.3	3.77	5.65	.63	10.05	9.15	-0.90
1934	3.98	100.5	4.06	5.66	.63	10.35	9.72	-0.63
1935	4.03	100.9	4.11	5.68	.63	10.42	10.25	-0.17
1936	4.06	103.7	4.14	5.84	.63	10.61	10.75	+0.14
1937	4.52	104.8	4.61	5.90	.63	11.14	10.88	-0.26
1938	5.03	105.7	5.13	5.95	.63	11.71	10.91	-0.80
1939	5.25	108.2	5.35	6.09	.63	12.07	12.25	+0.18
1940	5.54	109.3	5.65	6.15	.63	12.43	13.01	+0.58
1941	5.73	110.5	5.84	5.22	.63	12.59	13.20	+0.61
				Totals		194.75	196.27	+1.52

TABLE 4

S From	S To	S Amount	Deviation	No. of Cases	Average S	Average Deviation
2.00	2.99	2.51	- 0.71			
		2.63	- 0.37			
		2.62	- 0.79			
		2.70	+ 0.27			
		2.71	+ 0.37			
	Totals	13.17	- 1.23	5	2.63	- 0.25
3.00	3.99	3.02	+ 0.10			
		3.34	+ 0.09			
		3.33	+ 0.74			
		3.51	+ 0.48			
		3.70	- 0.90			
		3.98	- 0.63			
	Totals	20.88	- 0.12	6	3.48	- 0.02
4.00	4.99	4.01	+ 0.30			
		4.32	+ 0.99			
		4.03	+ 1.57			
		4.52	- 0.17			
		4.03	- 0.17			
		4.06	+ 0.14			
		4.52	- 0.26			
	Totals	29.49	+ 2.40	7	4.21	+ 0.34
5.00	5.99	5.03	- 0.80			
		5.25	+ 0.18			
		5.54	+ 0.58			
		5.73	+ 0.31			
	Totals	21.55	+ 0.47	4	5.39	+ 0.12

TABLE 5

Year	(1) Expenses S	(2) Investment T	(3) Revenue f(S)	(4) Revenue f(T)	(5) Constant	(6) 34445 Estimated Revenue	(7) Actual Revenue	Devi
1920	2.51	20.3	7.10	5.50	-8.97	3.63	3.62	-0.
1921	2.63	20.6	7.30	5.50	-8.97	3.83	4.10	+0.
1922	2.62	30.2	7.30	6.10	-8.97	4.43	4.21	-0.
1923	2.70	31.4	7.40	6.20	-8.97	4.63	5.42	+0.
1924	2.71	35.0	7.40	6.33	-8.97	4.78	5.73	+0.
1925	3.02	53.2	8.25	8.30	-8.97	6.53	6.81	+0.
1926	3.34	59.7	8.25	8.30	-8.97	7.58	7.48	-0.
1927	3.33	60.2	8.25	8.30	-8.97	7.58	8.15	+0.
1928	4.01	77.5	9.25	9.70	-8.97	9.98	9.38	-0.
1929	4.32	78.6	9.40	9.75	-8.97	10.18	10.45	+0.
1930	4.03	80.7	9.25	9.80	-8.97	10.08	10.85	+0.
1931	4.52	90.2	9.75	10.25	-8.97	11.03	10.15	-0.
1932	3.51	90.8	8.50	10.25	-8.97	9.78	9.80	+0.
1933	3.70	100.3	8.80	10.45	-8.97	10.28	9.15	-1.
1934	3.98	100.5	9.20	10.50	-8.97	10.73	9.72	-1.
1935	4.03	100.9	9.25	10.50	-8.97	10.78	10.25	-0.
1936	4.06	103.7	9.30	10.50	-8.97	10.83	10.75	-0.
1937	4.52	104.8	9.75	10.50	-8.97	11.28	10.88	-0.
1938	5.03	105.7	10.30	10.50	-8.97	11.83	10.91	-0.
1939	5.25	108.2	10.40	10.60	-8.97	12.03	12.25	+0.
1940	5.54	109.3	10.50	10.60	-8.97	12.13	13.01	+0.
1941	5.73	110.5	10.60	10.70	-8.97	12.33	13.20	+0.
		Totals	195.00	198.60		196.26	196.27	+0.

M_y = 8.92

Derivation of Constant in Column (5)

$$M_y - \left(\frac{\Sigma f(S) + \Sigma f(T)}{n}\right) = 8.92 - 17.89 = -8.97$$

TABLE 6

S From	S To	S Amount	Deviation	No. of Cases	Average S	Average Deviation
2.00	2.99	2.51	- 0.01			
		2.63	+ 0.27			
		2.62	- 0.22			
		2.70	+ 0.79			
		2.71	+ 0.95			
	Totals	13.17	+ 1.78	5	2.63	+ 0.3
3.00	3.99	3.02	+ 0.28			
		3.34	- 0.10			
		3.33	+ 0.57			
		3.51	+ 0.02			
		3.70	- 1.13			
		3.98	- 1.01			
	Totals	20.88	- 1.37	6	3.48	- 0.2
4.00	4.99	4.01	- 0.60			
		4.32	+ 0.27			
		4.03	+ 0.77			
		4.52	- 0.88			
		4.03	- 0.53			
		4.06	- 0.08			
		4.52	- 0.40			
	Totals	29.49	- 1.45	7	4.21	- 0.2
5.00	5.99	5.03	- 0.92			
		5.25	+ 0.22			
		5.54	+ 0.88			
		5.73	+ 0.87			
	Totals	21.75	+ 1.05	4	5.39	+ 0.2

TABLE 7

Year	(1) S Expenses	(2) Investment T	(3) Revenue f(S)	(4) Revenue f(T)	(5) Constant	(6) 34445 Estimated Revenue	(7) Actual Revenue	(8) Devi
1920	2.51	20.3	7.60	5.50	-9.13	3.97	3.62	-0.3
1921	2.63	20.6	7.70	5.50	-9.13	4.07	4.10	+0.
1922	2.62	30.2	7.70	6.30	-9.13	4.87	4.21	-0.
1923	2.70	31.4	7.75	6.60	-9.13	5.22	5.42	+0.
1924	2.71	35.0	7.75	7.00	-9.13	5.62	5.73	+0.
1925	3.02	53.2	7.85	8.30	-9.13	7.02	6.81	-0.
1926	3.34	59.7	8.15	8.80	-9.13	7.82	7.48	-0.
1927	3.33	60.2	8.15	8.80	-9.13	7.82	8.15	+0.
1928	4.01	77.5	9.00	9.80	-9.13	9.67	9.38	-0.
1929	4.32	78.6	9.40	9.90	-9.13	10.17	10.45	+0.
1930	4.03	80.7	9.00	10.20	-9.13	10.07	10.85	+0.
1931	4.52	90.2	9.70	10.00	-9.13	10.57	10.15	-0.
1932	3.51	90.8	8.25	10.00	-9.13	9.12	9.80	+0.
1933	3.70	100.3	8.50	10.25	-9.13	9.62	9.15	-0.
1934	3.98	100.5	9.00	10.25	-9.13	10.12	9.72	-0.
1935	4.03	100.9	9.00	10.25	-9.13	10.12	10.25	+0.
1936	4.06	103.7	9.10	10.25	-9.13	10.22	10.75	+0.
1937	4.52	104.8	9.70	10.25	-9.13	10.82	10.88	+0.
1938	5.03	105.7	10.40	10.25	-9.13	11.52	10.91	-0.
1939	5.25	108.2	10.60	10.40	-9.13	11.87	12.25	+0.
1940	5.54	109.3	11.50	10.50	-9.13	12.87	13.01	+0.
1941	5.73	110.5	11.70	10.50	-9.13	13.07	13.20	+0.
		Totals	197.50	199.60		196.24	196.27	+0.

M = 8.92

Derivation of Constant in Column (5)

$$M_y - \left(\frac{\Sigma f(S) + \Sigma f(T)}{n}\right) = 8.92 - 18.05 = -9.13$$

en expressed as a function of investnt while expenses are held constant their average value. These equations e respectively:

$$R = 0.63 + 1.019S + (0.0563 \times 76.01)$$
$$= 4.91 + 1.019S$$

and

$$R = 0.63 + (1.019 \times 3.94) + 0.0563T$$
$$= 4.64 + 0.0563T$$

The linear equations are plotted on igures 1 and 2. Because the process adjusting these linear equations is ngthy and is repeated in order to get e "second approximation" curve, the ta for Figure 1 only are explained in tail.

The deviations in column 8 of Table are now grouped as shown in Table and the average deviation plotted ove or below the straight line R = 91 + 1.019S at the corresponding lues of average S. These deviations ove or below the straight line are now ned with a smooth curve called the irst approximation" curve in which y the net linear effects of the expense riable have been eliminated. Similar rouping of the deviations with values r the investment variable produce the irst approximation" curve shown in gure 2. Values for revenue as a nction of expenses and then as a funcn of investment are now read from se "first approximation" curves. Ta- 5 shows these values and also deves a new set of deviations between tual and estimated revenues.

The grouping of deviations as shown Table 4 is now repeated using the viations of Table 5. These deviations present the elimination of only the ear effects of the investment variable on expenses, and the expense variable on investment. Now further changes in the shapes of the expense and investment curves can be determined. Table 6 shows the grouping of the deviations from Table 5 for the "second approximation" of the expense curve. The average deviations are now plotted above or below the "first approximation" curve and the smooth curve that they determine is labelled "second approximation." Similar groupings are made for the values of investment and the "second approximation" curve drawn on Figure 2.

Now a new set of estimated values for operating revenue first as a function of expenses and second as a function of investment can be determined in which the relations between expenses and revenue and investment and revenue approach closer to their true curvilinear relations. These values are shown in Table 7. A comparison of the deviations in Table 7 with those of Table 3 shows that there has been a general reduction in the year-to-year sizes of the deviations indicating that the "second approximation" curves show the curvilinear relations between the independent variables of expenses and investment and the dependent variable of revenue better than was indicated by the linear equation used in Table 3.

The next step concerns the translation of the data in Table 7 into the percentages of revenue that have been contributed individually by expenses and investment. Each year's data contains an amount for revenue from expenses plus an amount for revenue from investment less a constant. Mathematically this constant cannot be stated in the terms of the variables, but must be treated empirically in order to distribute it over the elements of expenses and investment. No rule can be stated on how this should be done, but as it was assumed at the beginning that elements other than expenses and investment which contribute to revenue have a uniform effect on both expenses and investment, it is reasonable to assume that the constant of — 9.13 in Table 7 can be distributed pro rata over the variables of expense and investment. By adopting this method the constant can be dropped and the values of the variables alone allowed to state the percentages of revenue contributed by expenses and investment. The percentages are shown in Table 8.

With the details of plant investments and operating expenses, and these percentages it is now possible to derive the amount of operating revenue contributed by each of the major subdivisions such as hydro production, steam production, etc. For the year 1941, the amounts of revenue derived from expenses and investment respectively are:

Revenue from:		
Expenses	52.70%	$ 6.96
Investment	47.30%	6.24
	100.00%	$13.20

The segregation of this amount of revenue into the revenue from each major subdivision for the year 1941 is shown in Table 9. By repeating the calculations for each year using the plant and expense details for each year and the corresponding percentages from Table 8, oper-

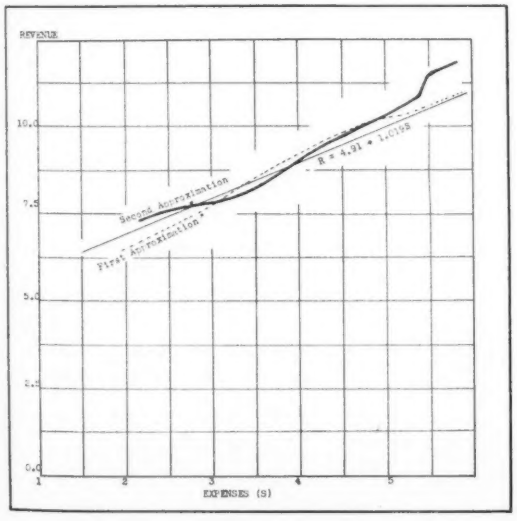


Fig. 1

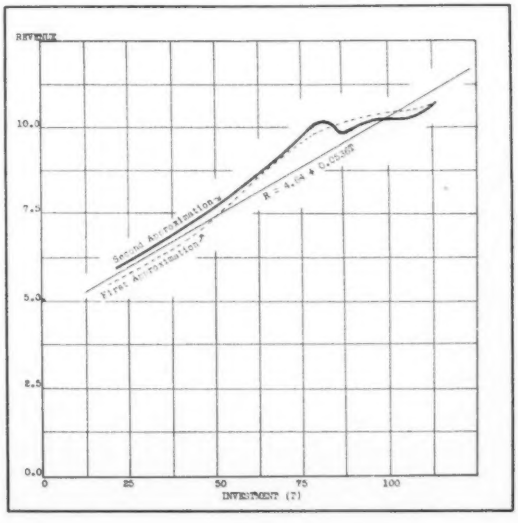


Fig. 2

TABLE 8

Year	f (S) Expenses	f (T) Investment	Total	Revenue Percentage From Expenses	Revenue Percentage From Investment
1920	7.60	5.50	13.10	58.02	41.98
1921	7.70	5.50	13.20	58.33	41.67
1922	7.70	6.30	14.00	55.00	45.00
1923	7.75	6.60	14.35	54.01	45.99
1924	7.75	7.00	14.75	52.54	47.46
1925	7.85	8.30	16.15	48.61	51.39
1926	8.15	8.80	16.95	48.08	51.92
1927	8.15	8.80	16.95	48.08	51.92
1928	9.00	9.80	18.80	47.87	52.13
1929	9.40	9.90	19.30	48.70	51.30
1930	9.00	10.20	19.20	46.88	53.12
1931	9.70	10.00	19.70	49.24	50.76
1932	8.25	10.00	18.25	45.21	54.79
1933	8.50	10.25	18.75	45.33	54.67
1934	9.00	10.25	19.25	46.75	53.25
1935	9.00	10.25	19.25	46.75	53.25
1936	9.10	10.25	19.35	47.03	52.97
1937	9.70	10.25	19.95	48.62	51.38
1938	10.40	10.25	20.65	50.36	49.64
1939	10.60	10.40	21.00	50.48	49.52
1940	11.50	10.50	22.00	52.27	47.73
1941	11.70	10.50	22.20	52.70	47.30

TABLE 9

Subdivision	1941 Gross Revenue Derived From Expenses %	Expenses Amount	Investment %	Investment Amount	Total Revenue
Hydro	20.18	$ 1.40	31.89	$ 1.99	$ 3.39
Steam) Transmission) Distribution) Commercial) General)	79.82	5.56	68.11	4.25	9.81
Totals	100.00	$ 6.96	100.00	$ 6.24	$13.20

TABLE 10

Year	Hydro Revenue	Kilowatt-hours	Kilowatts	Investment
1920	$0.67	189	0.040	$ 6.38
1921	0.83	258	.058	6.40
1922	1.15	342	.065	11.35
1923	1.60	365	.101	16.80
1924	1.70	416	.110	16.85
1925	2.08	482	.113	23.84
1926	2.27	543	.113	25.38
1927	2.32	651	.115	25.40
1928	2.52	589	.140	30.60
1929	2.72	580	.147	33.15
1930	2.60	595	.149	33.17
1931	2.22	505	.149	33.30
1932	2.15	687	.150	33.32
1933	2.03	728	.151	33.35
1934	2.23	690	.153	33.60
1935	2.33	802	.153	33.63
1936	2.39	925	.153	33.80
1937	2.60	910	.153	34.00
1938	2.62	905	.155	34.15
1939	3.01	927	.201	34.20
1940	3.38	1051	.203	34.22
1941	3.39	1206	.234	34.25

TABLE 11

Year	(1) KWH J	(2) KW K	(3) Invest. L	(4) Revenue f(J)	(5) Revenue f(K)	(6) Revenue f(L)	(7) Constant	(8) 4454647 Estimated Revenue	(9) Actual Revenue	Devia
1920	189	0.040	6.38	1.90	1.80	1.90	-4.40	1.20	0.67	-0.
1921	258	.058	6.40	1.85	1.87	1.90	-4.40	1.22	0.83	-0.
1922	342	.065	11.35	1.80	1.99	1.65	-4.40	1.04	1.15	40.
1923	365	.101	16.80	1.76	2.28	1.90	-4.40	1.44	1.60	40.
1924	416	.110	16.85	1.75	2.32	1.90	-4.40	1.47	1.70	40.
1925	482	.113	23.84	1.95	2.32	2.09	-4.40	1.96	2.08	40.
1926	543	.113	25.38	2.15	2.32	2.20	-4.40	2.27	2.27	0.
1927	651	.115	25.40	2.28	2.33	2.20	-4.40	2.41	2.32	-0.
1928	589	.140	30.60	2.24	2.10	2.40	-4.40	2.34	2.52	40.
1929	580	.147	33.15	2.23	2.02	2.45	-4.40	2.31	2.72	40.
1930	595	.149	33.17	2.28	2.02	2.45	-4.40	2.36	2.60	40.
1931	505	.149	33.30	2.03	2.02	2.46	-4.40	2.11	2.22	40.
1932	687	.150	33.32	2.27	2.01	2.46	-4.40	2.34	2.15	-0.
1933	728	.151	33.35	2.27	2.01	2.46	-4.40	2.34	2.03	-0.
1934	690	.153	33.60	2.27	2.03	2.47	-4.40	2.37	2.23	-0.
1935	802	.153	33.63	2.34	2.03	2.47	-4.40	2.44	2.33	-0.
1936	925	.153	33.80	2.44	2.03	2.48	-4.40	2.55	2.39	40.
1937	910	.153	34.00	2.42	2.05	2.48	-4.40	2.53	2.60	-0.
1938	905	.155	34.15	2.42	2.12	2.49	-4.40	2.63	2.62	-0.
1939	927	.201	34.20	2.43	2.52	2.49	-4.40	3.04	3.01	-0.
1940	1,051	.203	34.22	2.67	2.53	2.49	-4.40	3.29	3.38	40.
1941	1,206	.234	34.25	2.75	2.56	2.49	-4.40	3.39	3.39	0.
			Totals	48.50	47.25	50.10		49.05	49.01	-0.
								M_y =	2.23	

Derivation of Constant in Column (7)

$$M_y - \left(\frac{\Sigma f(J) + \Sigma f(K) + \Sigma f(L)}{n} \right) = 2.23 - 6.63 = -4.40$$

TABLE 12

Year	Hydro Revenue Percentage From Kilowatt-hours	Kilowatts	Investment
1920	33.93	32.14	33.93
1921	32.92	33.27	33.81
1922	33.09	36.56	30.33
1923	30.14	39.04	30.82
1924	29.81	39.52	30.67
1925	30.66	36.48	32.86
1926	32.23	34.78	32.99
1927	33.48	34.21	32.31
1928	33.23	31.16	35.61
1929	33.23	30.11	36.66
1930	33.73	29.88	36.39
1931	31.18	31.03	37.79
1932	33.68	29.82	36.50
1933	33.68	29.82	36.50
1934	33.53	29.99	36.48
1935	34.21	29.68	36.11
1936	35.11	29.21	35.68
1937	34.92	29.29	35.79
1938	34.42	30.16	35.42
1939	32.66	33.87	33.47
1940	34.72	32.90	32.38
1941	35.31	32.73	31.96

ating revenue can be distributed to all major subdivisions for the years 1920 to 1941, inclusive.

The next step in this process is to determine the amount of hydro production revenue applicable to selected hydro production units. Basic assumptions are now set up on how total hydro production revenue is to be distributed. It is assumed that each hydro production unit contains three elements that can be used to equitably distribute total hydro production revenue to the various units of the hydro production system. They are:

1. Investment
2. Kilowatthours generated
3. Kilowatts operating capacity

Table 10 shows these elements together with hydro production operating revenue for the years 1920 to 1941, inclusive.

Following the basic assumption that hydro production revenue is a function of investment, kilowatthours generated and kilowatts operating capacity, the next step is to express the mathematical relationship by the formula:

$$R = a + bJ + cK + dL,$$

in which

R = Hydro production revenue
J = Annual hydro-generated kilowatt-hours
K = Kilowatts operating capacity of hydro plant
L = Investment in hydro production, and
a, b, c, and d are mathematical constants.

The quantities in Table 10 are n treated as in Table 2. The proces the same but because there is one m variable the process is somewhat lon and involves simultaneous equations w three unknowns. The calculations not repeated here, only the final equat being shown.

$$R = 0.35 + 0.00099J + 3.280K + 0.0289$$

Steps are now taken with this equat similar to those that are illustrated

TABLE 13

	Kilowatthours %	Kilowatthours Revenue	Kilowatts %	Kilowatts Revenue	Investment %	Investment Revenue	Total Revenue
Hydro Power Unit A	14	$0.168	26	$0.289	40	$0.433	$0.890
Hydro Power Unit B	25	0.299	20	0.222	15	0.163	0.684
All Other Hydro Units	61	0.730	54	0.599	45	0.487	1.816
Totals	100	$1.197	100	$1.110	100	$1.083	$3.390

bles 3 and 7, inclusive, and Figures and 2. After the "second approxiation" curves are drawn, the final reve figures are as shown in Table 9. ith this table it is now possible to state percentage of hydro production reve contributed by each of the elements kilowatthours, kilowatts operating pacity and investment. Using the data columns 4, 5, and 6 of Table 11, the spective percentages are as shown in able 12.

It is now possible to derive operating evenue for any combination of hydro erating units. Applying the 1941 per-ntages in Table 12 to the 1941 hydro oduction revenue of $3.390 derives the llowing:

Revenue from:		
Kilowatthours generated	35.31%	$1.197
Kilowatts operating capacity	32.73%	1.110
Investment	31.96%	1.083
Total	100.00%	$3.390

Derivation of individual revenues for ydro units is demonstrated in Table 13.

With the derivation of operating revenue for a unit of the hydro production ystem, the process described herein is complete. All other details needed to mpile net earnings of a hydro power nit such as operating expenses, taxes, tc., would be available. When these ata are assembled and the net earnings of the different production units compiled, the process is ready for its most ritical check, that of reasonableness. Two tests of reasonableness which must be satisfactorily passed are:

1. Higher rates of return for large modern plants than are derived for the older and smaller plants, and
2. Reasonable comparisons of either rates of return or net earnings from large units which are radically different in investment, operating capacity, and kilowatthour output.

* * * *

References for the development of this ethod are:

"Statistical Methods" by F. C. Mills.

"Economic Statistics" by W. L. Crum d A. C. Patton.

"An Introduction to the Theory of tatistics" by G. U. Yule.

"Business Statistics" by G. R. Davies d D. Yoder.

"Methods of Correlation Analysis" by M. Ezekiel.

"Business Statistics" by J. R. Riggleman and I. N. Frisbee.

Value of Good Lighting in War Production

(*Continued from page 51*)

contrast, (c) for long periods of time. To meet these requirements, illumination levels above 100 footcandles are recommended.

To provide illumination of this order, a combination of at least 20 footcandles of general lighting plus specialized supplementary lighting is necessary. The design and installation of the combination systems must not only provide a sufficient amount of light but also must provide the proper direction of light, diffusion, eye protection, and insofar as possible must eliminate direct and reflected glare as well as objectionable shadows.

Group B

This group of visual tasks involves (a) the discrimination of fine detail under conditions of (b) a fair degree of contrast (c) for long periods of time. Illumination levels from 50 to 100 footcandles are required.

To provide illumination of this order a combination of at least 20 footcandles of general lighting plus specialized supplementary lighting is necessary. The design and installation of the combination systems must not only provide the proper direction of light diffusion, eye protection, and insofar as possible must eliminate direct and reflected glare as well as objectionable shadows.

Group C

The seeing tasks of this group require the discrimination of fine detail by utilizing (a) the reflected image of a luminous area or (b) the transmitted light from a luminous area.

The essential requirements are (1) that the luminous area shall be large enough to cover the surface which is being inspected and (2) that the brightness be within the limits necessary to obtain comfortable contrast conditions. This involves the use of sources of large area and relatively low brightness in which the source brightness is the principal factor rather than the footcandles produced at a given point.

A minimum of Glare, either direct or reflected, is important. Direct Glare is second only to an inadequate quantity of light as a hindrance to seeing in productive work. Direct Glare may be caused by improperly shielded light sources or by large areas of windows if the workman has to face them. It reduces visibility and causes annoyance and discomfort, with accumulative results which impede production immediately or at least in the long run. Reflected Glare can seriously impair visibility, particularly when it comes from the object being viewed. In fact, the choice of the lighting system should be dictated in part by the type of surface to be worked in the area. Thus, if highly polished specularly reflecting surfaces are to be worked, the lighting system should present low surface brightnesses as viewed from the work.

Distribution of Light from the general lighting system should be uniform in order that all locations throughout the area will be provided with the same amount of light. Proper distribution assures that all parts of the area will be equally useful and therefore permits maximum utilization of floor space. Suitable supplementary lighting can then be provided for the more critical seeing tasks.

Directional lighting can often be utilized to reveal details which are normally practically invisible, especially at the work point. Large-area, low-brightness light sources are quite useful for many inspection problems, particularly where the work is with polished surfaces, and where highly uniform, shadowless and glare-free lighting is required. For inspection of polished surfaces the light-source brightness is the principal factor rather than the footcandles produced at a given point.

Good diffusion results in soft luminous shadows and, therefore, in better seeing conditions. In general, the shadow condition should reveal rather than hide important objects. Only in certain special cases are harsh shadows desirable.

Proper Brightness Contrast means a suitable range of brightness between that of the work and that of other surfaces in the field of view. For maximum seeing ease, brightness contrast should be kept low. There is some advantage, however, in having the point of work somewhat brighter than the surroundings in order to help focus the involuntary attention of the operator on the work. Where supplementary lighting is used, the brightness of the work should not exceed that of the surroundings by more than 10 to 1. By controlling the reflection factors of the background and surroundings, much can be accomplished in this direction.

Reports of Joint Subcommittee on Development and Research

THE fifth volume of Engineering Reports of the Joint Subcommittee on Development and Research containing Reports Nos. 39-49 continues a series that began with the publication of Volume I in 1930. This printed record presents the results of investigations by the Joint Subcommittee of the various problems of coordination affecting the power and telephone companies. The quantitative information thus made available, and the methods and devices described, provide an adequate basis for securing coordination in most situations of the types now being encountered. This is evidenced by the fact that most coordination problems are now solved jointly by the operating companies concerned without the necessity for elaborate and costly field investigations. Special cases for which available methods are inadeuate will be the subject of future investigations by the Joint Subcommittee, as likewise will be situations which may arise from new developments in the two arts.

A brief description of the various reports in Volume V is given below. As indicated by these summaries, some of the information in the volume is of value in power system operating and design problems in addition to its application in coordination.

Report No. 39 — Characteristics of Power System Faults to Ground. This report gives the results of a study which was undertaken to determine the characteristics of power system ground faults. While the study was made primarily to obtain data on certain characteristics useful in connection with inductive coordination problems, the analysis has been made comprehensive with the object of presenting information of more general interest as well. From the standpoint of inductive coordination studies, probably the most important section of the report is that dealing with the determination of representative values of fault resistance. Other data presented include such items as the cause of ground current disturbances, their frequency of occurrence, monthly distribution, duration, method of clearance and wave trace characteristics.

Report No. 40—Inductive Coordination of Rural Power and Telephone Systems. In the coordination of telephone and power distribution systems in rural areas the conditions encountered differ in a number of respects from the corresponding conditions in urban areas. This report presents the results of a study of these conditions, including field measurements of rural power systems wave shape and telephone circuit noise under a variety of operating conditions, supplemented by a theoretical discussion of the factors affecting the inductive influence of rural circuits, including the impedance-to-ground of various types of distribution circuits and the division of residual current between neutral wire and ground. Methods are presented for estimating the harmonic ground-return currents and I-T product of various types of rural power circuits. Coordinative measures which have been found applicable to the power and telephone circuits are described, and test data are included to indicate their effectiveness.

Report No. 41—Short-Circuiting Relay Protectors. The application of short-circuiting relay protectors to telephone circuits in low-frequency induction cases is discussed. Both the unit type and multi-grounding type protectors are described and the fields of use for both are covered. A practical method for planning an installation of SCR protectors along open-wire lines for the purpose of limiting voltages-to-ground due to low-frequency induction is outlined in the report and results obtained in field tests and trial installations are described. This is supplemented by a discussion of the underlying theory.

Report No. 42—Inductive Coordination Aspects of Petersen Coil Grounding. This report discusses those features of a Petersen coil - equipped power system which are of importance from the inductive coordination standpoint. As a background for this discussion, a brief description of the theory of operation and extent of use of the Petersen coil is given, following which those features affecting inductive influence, such as residual current distribution, duration of faults, and percentage of faults likely to be cleared without breaker operation, are considered in more detail. Consideration is also given to means used for clearing permanent faults and to possible noise induction effects.

Report No. 43—Effects of Bonding Exchange Aerial Telephone C[illegible] Sheaths to Multi-Grounded Power N[illegible] trals. Results are given of an inves[illegible] tion of the shielding benefits derive[illegible] bonding the sheaths of aerial exch[illegible] telephone cables to multi-grounded p[illegible] system neutrals. The theoretical di[illegible] sion is supported by data from an ex[illegible] sive survey of the effects of sheath-[illegible] tral bonding on noise, low-frequency [illegible] tage and electrolysis conditions in [illegible] telephone plant. Both areas serve[illegible] public water systems and non-water-[illegible] areas are covered. Bonding of exp[illegible] aerial exchange telephone cable she[illegible] to multi-grounded power system neu[illegible] in areas served by public water sys[illegible] results in a reduction in noise at l[illegible] equal to that obtainable by connecti[illegible] other low-impedance grounds. In [illegible] public water-pipe areas the noise re[illegible] tions effected by bonding depend [illegible] the resistance to ground of the ne[illegible] conductor.

Report No. 44—Neutralizing Tr[illegible] formers. Two types of neutrali[illegible] transformers are described, one called [illegible] "power station" neutralizing trans[illegible] mer, developed for use on commun[illegible] tion circuits subject to ground pote[illegible] rise at power stations the other called [illegible] "toll line" neutralizing transformer, [illegible] tended for reducing the effects of l[illegible] frequency induction on open-wire t[illegible] phone lines. Following a general in[illegible] duction, a section is devoted to the [illegible] type of transformer, discussing its f[illegible] tions and uses. Characteristics are g[illegible] from which the effectiveness of t[illegible] transformers in particular situations [illegible] be determined, following which [illegible] methods that have been used in ins[illegible] ing and protecting them and field [illegible] perience with them are discussed. [illegible] last section deals with the second t[illegible] of neutralizing transformer, giving [illegible] theory of its operation and a descrip[illegible] of its characteristics, including its [illegible] tion on communication facilities, [illegible] of which were determined from [illegible] measurements as described.

Report No. 45—Frequency Wei[illegible] ing for Message Circuit Noise. A [illegible] sage circuit noise weighting for us[illegible] measuring telephone circuit noise in p[illegible] involving the new telephone set (F[illegible] 101) is presented, together with a [illegible] scription of the judgment tests, m[illegible] over a period of four years, from w[illegible] the weighting was derived. A brief s[illegible] ment is also given of the effect of [illegible] new weighting on the established [illegible]

(*Continued on page* 46)

PERSONALS

ROBERT F. PACK has been elected irman of the board of directors of the rthern States Power Company of nnesota following acceptance of his gnation as president of the company. announced a year ago that he desired etire as president not later than Deber 31, 1942. This does not affect office of president of the Northern es Power Company of Delaware, ch he continues to hold.

T. D. CROCKER, who has been servthe Minnesota company as vice presnt and general manager, succeeds Mr. k as president, and now becomes presnt and general manager.

Mr. Pack who reached his sixty-eighth hday October 1, has spent his life in utility business, entering the Toronto anada) Electric Light Company as office boy February 1, 1891. He left re in 1912, at which time he was eral manager, and took a position h the Northern States Power Comy, serving as vice president and genmanager for about twenty years, then as president and general manr for ten years. He retired as genmanager last March, at which time Crocker became vice president and eral manager.

Mr. Crocker has been associated with rthern States Power Company thirty rs. Born in Elyria, Ohio, he attendd Cleveland high school and then employed by Lincoln Electric Comy of Cleveland until he entered Ohio e University, where he was graduin 1904.

He then was in the service of the waukee Electric Railway and Light pany until 1912, starting in the er plant department, and, after ral promotions, becoming commercial neer.

Mr. Crocker joined Northern States commercial engineer in St. Paul in 2, and in 1913 was made assistant he general manager. Mr. Crocker ctive as one of the civic leaders of nneapolis.

The Sales Department of the Pacific and Electric Company at headters in San Francisco has made the owing changes to fill gaps made by calling of men into military service: YNE CLARK, administrative assistto General Sales Manager O. R. Doerr, has been made merchandise manager to fill the vacancy made by the leaving of Capt. Arthur Miller. GUS STRICKER becomes administrative assistant. R. I. MENDES, who has been connected with the company for a number of years, and who recently has been engaged in priority work in the purchasing department, moves to the general sales department.

E. I. SNYDER, formerly tax supervisor of the Portland (Ore.) General Electric Company has been named assistant treasurer. LESTER G. PARK, formerly assistant treasurer and general auditor, is now in the Navy.

HERBERT H. IDLE has been named secretary of the Arizona Edison Company, Inc. He had been Globe division manager and has been succeeded there by T. T. Parker.

J. A. MORROW, results engineer at the Byng station of the Oklahoma Gas and Electric Company has been appointed assistant chief engineer of that plant. In this capacity he will assist Chief Engineer Ira B. Watkins in the responsibility for operating and maintaining the plant, taking charge in Mr. Watkins' absence, while continuing his present duties as to results and testing activities. Mr. Morrow, who has been connected with the Oklahoma utility for more than 18 years, served previously at Byng and also had a fine record of achievement at Horseshoe Lake station and Huey station.

B. J. BRAHENEY, central division auditor for the Oklahoma Gas and Electric Co. has been made division manager. He has been a member of the Oklahoma Gas organization for 18 years, the last twelve of which as auditor for the division of which he now assumed the managership.

EDWARD L. ROBERTS, sales manager of the Housatonic division of the Connecticut Power Company, Canaan, Conn., for the past 19 years has retired.

FRANK J. REYNOLDS, engineer of the Hartford Electric Light Company retired from active duty on December 31, after 53 years of service to the electrical industry, including 25 years with the Hartford company. Mr. Reynolds retains his association with the company in an advisory capacity.

After graduating from Dartmouth in 1889, Mr. Reynold's first connection was with Thomson-Houston Company at Lynn, Mass., later a part of the General Electric Company. He supervised the installation of generating apparatus in many cities. Among these were the street railway plant in Cincinnati; installations for the U. S. Navy, street railway system and Potomac Electric Company in Washington, D. C. He installed central station equipment in Chicago, Baltimore, St. Louis, Detroit and New Jersey. In 1907 he installed generators for the Hudson-Manhattan Tunnel, and in 1910 came to Hartford to install a turbine at the Dutch Point Station. During 1917, while in New York, engaged in the electrification of the New York Central Terminal, he was granted leave of absence to come again to Hartford to supervise another powerhouse addition. As an outcome, he became associated with the Hartford company, and through the last quarter of a century has been occupied with the many construction projects of the company, during which time the output of the company has multiplied 10 times.

J. L. COOPER of Harrison, Ark., manager of the Arkansas Power and Light Company's Ozark Division, has rounded out 25 years continuous service with the company and will receive a gold emblem and five stars.

J. M. STUART, formerly supervisor of the underground department of the Dayton Power and Light Company, Dayton, Ohio, has been named manager of the electric division of the company.

PHILLIP V. COLBURN has been appointed to the position of manager of the Cloquet division of Minnesota Power and Light Company succeeding the late W. J. Wilkinson. Starting with the Minnesota Power and Light Company as a young man in 1928, he was first employed as a groundman on the line crew. From this position he successively worked his way through the various positions of lineman, estimating engineer, line foreman, and in 1934 he was made division superintendent, the position he held at the time of his appointment as division manager.

Reports of Joint Subcommittee

(*Continued from page* 46)

Multi-Phase Rectifiers. Supplementing the basic study in Engineering Report No. 22 of wave shape on power systems supplying mercury-arc rectifiers, the present report discusses subsequent developments in applying the principle of multi-phase operation to large capacity installations of rectifiers. It has been found practicable, by suitably adjusting the phase relations between the voltages applied to individual 6-phase and 12-phase units making up an installation, to improve the wave form in the a-c power-supply circuits and to reduce the likelihood of inductive coordination problems. This has been accomplished either by design in the individual rectifier transformers or by the insertion of phase-shifting transformers in the a-c circuits supplying the individual units. A discussion is given of the effects of unbalances due to shut-down of individual units for maintenance, inequalities in the impedances of the individual transformers or phase shifters, and inequalities in the d-c loads on the individual units. Supporting data taken from the results of field tests are also included.

Volume V of Engineering Reports of the Joint Subcommittee on Development and Research. Edison Electric Institute. Bell Telephone System. Price $10.00; to members $5.00.

CONVENTIONS AND MEETINGS

FEBRUARY

8-9 Accident Prevention Committee, EEI, Hotel Gibson, Cincinnati, Ohio.
8-9 Prime Movers Committee, EEI, Deshler-Wallick Hotel, Columbus, Ohio.
11-12 Transmission and Distribution Committee, EEI, William Penn Hotel, Pittsburgh, Pa.

APRIL

20-23 National Electrical Manufacturers Association, Palmer House, Chicago, Ill.
23-24 Missouri Association of Public Utilities, Elms Hotel, Excelsior Springs, Mo.
26-28 American Society of Mechanical Engineers, Davenport, Iowa.

MAY

10-14 National Fire Protection Association, Palmer House, Chicago, Ill.
21-23 Westinghouse Agent-Jobbers Association, The Homestead, Hot Springs, Va.

Utilities Deliver 24 Million Lbs of Copper for War Needs

Scrap drives and continuous salvage programs of the electric utility companies in 1942 netted 24,000,000 lb of copper for the nation's war needs, together with large quantities of aluminum, brass, iron, steel, lead, zinc, rubber and other scarce and urgently needed material.

The copper turned over to scrap dealers and mills represented approximately 10 per cent of the normal annual copper requirements of the electric industry, which is the largest user in peace time of the now precious metal. Concurrently with their release of copper to primary military needs, the electric utilities, basic source of power for the war industries, by holding down their own use of copper and other metals to lowest possible levels through substitutions and reprocessing, freed many thousands of tons of new copper and steel for military purposes.

The thoroughness of the scrap collecting job is indicated by the fact that their potential copper salvage for 1943 will be about half the amount gathered in 1942. Nothing was overlooked in gathering scrap for the government, and the list of items scrapped ranged from the metal bases of broken lamps to entire power plants. A striking example of the latter was the dismantling and scrapping of the historic eight-story Edison Station at Philadelphia. Although the building was erected under the personal supervision of Thomas A. Edison, and [illegible] the city's first successful electric [illegible] and the first building in the U[illegible] States constructed specifically as a [illegible] erating plant, the present emer[illegible] forced the decision to raze the buil[illegible]

Included in the collections were [illegible] items as old boilers, smoke stacks, [illegible] generating sets, millions of feet of [illegible] per wire, steam and pipe valves, [illegible] pumps, and watthour meters.

Indicative of the length to which [illegible] ity organizations have gone in sub[illegible] tions and conservation is the report [illegible] one company that the use of ove[illegible] tons of steel a year is being saved by [illegible] struction from salvaged fir crossarm[illegible] certain items of line hardware nor[illegible] made of metal.

Nicholas Stahl

NICHOLAS STAHL, chief engineer of the Pennsylvania Power and Light Company, Allentown, Penn., died January 1 at the New Haven (Conn.) General Hospital at the age of 66.

Mr. Stahl entered the manufacturing branch of the electrical industry in 1907 when he joined the Westinghouse Electric and Manufacturing Co. at Pittsburgh in the capacity of engineer. In 1918 he transferred to the utility field, affiliating himself in that year with the Narragansett Electric Co., Providence, R. I. He served as general engineer and superintendent of generation for the Rhode Island utility until 1927 and the following year he was appointed chief engineer of the Allentown properties, the position he occupied at the tim[illegible] his death.

In the course of his engineering c[illegible] Mr. Stahl was active in the elect[illegible] industry's representative associati[illegible] holding membership on many commi[illegible] from time to time. During 1923-[illegible] he was vice chairman and chairma[illegible] the Prime Movers Committee of [illegible] National Electric Light Association[illegible] was a fellow of the American Insti[illegible] of Electrical Engineers; senior me[illegible] of the American Society of Mecha[illegible] Engineers; member Association of [illegible] son Illuminating Companies and c[illegible] man of its committee on electric sw[illegible] ing and switchgear 1939-1940; a[illegible] member of Pennsylvania Electric [illegible] sociation, and the American Socie[illegible] Testing Materials.

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1942-1943

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